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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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Volume 5 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

Address DIVISION OF FIRE CONTROL
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IT ISN'T OUR FIRE

PERCY E. MELIS

Forest Supervisor, Helena National Forest

The use by forest officers of the expression "It isn't our fire" as an explanation for failure to take action toward the suppression of a fire on forest lands unprotected by organized agencies is deplored by the author. In particular, he argues that a complacent and self-righteous attitude should be avoided. The loss to the Nation by such fires is just as great as though they were on lands owned by or protected by the United States or by the States. Although there are major obstacles to the extension of Federal fire protection, it is especially timely—in view of our over-all problem of national defense—to explore the possibilities of developing some means of furnishing adequate fire protection even though such means are not now apparent.

How many times have forest officers used the expression "It isn't our fire" and thereby disavowed responsibility for a fire burning on unprotected forest land? As an organization we should not be content with our own accomplishments and should avoid the appearance of complacency or smugness regarding fires on lands not under Forest Service protection. As a public agency, with well-developed fire-suppression facilities, we cannot afford to be self-satisfied nor should we be negligent in consideration and treatment of forest fires which do not endanger the national forests.

A recent incident will point up this discussion.

On the afternoon of July 9, 1940, a lightning storm passed over the vicinity of Helena setting 17 fires, 15 on national-forest land and 2 on unprotected forest lands. By 10 a. m., July 10, the 15 fires on the national forest were all either out or under control, while the two fires outside our protection boundary were booming along in crew-size proportions.

During the next 10 days we received several hundred inquiries about progress on these fires. Each inquiry was answered with a full explanation to the effect that our fire-control authorization does not permit us to spend public money in suppression of fires which do not endanger the national forests unless financial responsibility is accepted by the landowner. Many good citizens shook their heads in bewilderment, wondering why the valuable natural resources which we discuss so glibly should be permitted to burn so freely—especially when we maintain an organization trained and equipped for fire control.

In about 2 weeks the two fires on unprotected lands were finally extinguished by a combination of showers and prayers, and volunteer and private-owner effort, aided materially by lack of fuel.

The total area of the 15 fires on the national forest was held to about 20 acres, and the damage to natural resources was of no material consequence. The two other fires spread over literally thousands of acres—perhaps 6 or 7 thousand—of low-grade forest land. The loss

in timber and brush cover, potential timber growth, forage, soil productivity, wildlife habitat, watershed, recreation, and aesthetic values was just as distinctly a national loss as though this burned area had been on the national forest.

Should we indulge a feeling of satisfaction that this incident proves again the value of organized fire control and that the Forest Service has again demonstrated its effectiveness in fire suppression? No, not by any means. We should instead experience a feeling of futility and shame that after years and years of effort we must still stand by, more or less idly, with an efficient fire-fighting machine, all in gear and ready to go, actually watching our natural resources burn—merely because their burning does not endanger the national forest.

The incident I have just related is not an isolated case. During each of the last two fire seasons there has been more fire damage, more loss of public values, more loss to the Nation from uncontrolled fires on unprotected lands within sight of the supervisor's office here than on the entire Helena National Forest during these 2 years combined. The loss to the Nation is just as real and the damage just as great as though it were recorded in our fire reports and made the subject of a meeting of the board of fire review. I believe that a similar situation obtains wherever our national-forest lands are adjacent to other forest lands which do not have the benefit of organized fire protection.

Several obvious explanations may be made of this situation, but explanations do not solve the problem. It is easy to blame negligence by the counties or the States and indifference of the private landowner, and to say "It isn't our fire." But the loss still continues—loss that could be materially reduced were the real values lost better appreciated by all parties having an interest at stake.

It is high time that we thoroughly review the entire problem of the distribution of fire-control effort. Each year we willingly spend hundreds of thousands of dollars of public money in protecting from fire vast areas of inaccessible, almost unusable country of no commercial value. We do this because it is public property, because we have public money for that purpose, and because any forest fire is a recognized forest enemy. We spend this money without any material concern over the absence of commercial values at stake because we recognize the importance of the other forest values. Nevertheless, areas of far greater public value, although not publicly owned, are permitted to burn almost unchecked on account of the lack of recognition of the public interest. Is it not our fire?

One means of furnishing adequate protection would be to extend Federal protection, although it is recognized that the expansion of Federal forest-fire protection over other land ownerships would involve many complications, and that many practical as well as academic problems would be involved. No one, however, should balk at the abstract idea. Socialization in many ways has gone far beyond this and with less justification. In the control of predatory animals, plant pests and diseases, and in other instances too numerous to list here we recognize the public values at stake in private property. We now advocate the regulation of certain industrial operations of forest-land owners on account of the public interests involved. However, the extension of Federal protection is not necessarily the answer to this problem; it may be better to use all the resources of private initiative and inventiveness and of State cooperation.

Let us now recognize, however, with equal clarity that the public values at stake in forest land, regardless of ownership, warrant full and complete fire protection from one source or another.

It is not the purpose of this article to discuss the effectiveness of the Clarke-McNary law or of State and private fire-protection organizations. Also it is not the intention to outline a means through which adequate protection will be obtained for non-Federal lands, either through private initiative or Government assistance. The discussion should, however, stimulate thought so that thinking in the field of planning and cooperation will keep pace with developments in the more technical aspects of fire control.

The expression "It isn't our fire" cannot be accepted as fulfilling the responsibilities of the major forest-fire protection agency of the Nation. The situation described presents a challenge to the Forest Service that cannot be considered lightly.

Air Infantry and Smoke-Jumpers.—Development of air infantry is the subject of discussion in an article by Lieut. Col. William C. Lee in the January 1941 issue of the Infantry Journal.

Air infantry must receive parachute training similar to that given to men of the Air Corps for use in emergencies, although the training does not proceed to the point that it does with the parachute troops. Commenting upon the work of the Forest Service in Region 1, Colonel Lee says:

"Our new aerial development has naturally called for considerable study in order to find out what kind of equipment will serve best, especially for the parachute troops. In the course of this study it was found that the Forest Service, a branch of the Department of Agriculture, was using, out in the mountains of Montana, especially developed equipment for dropping groups of as many as six or eight men in isolated roadless forest areas to fight forest fires. Five officers representing the Office of the Chief of Infantry, the Air Corps, and the Infantry Board, went to Montana for a week to study the equipment and methods of the Forest Service. Every facility was extended to the visiting Army officers. This visit and the enthusiastic cooperation of the Forest Service enabled us to gain the full benefit of their experience and saved many weeks of experiment in the development of parachute troops."

FOREST DEFENSE IS NATIONAL DEFENSE

CRAWFORD R. BUELL

Division of Fire Control, Washington, D. C.

The slogan "Forest defense is national defense" which appears on the 1941 fire-prevention poster, might well have been applied to several articles in this issue of Fire Control Notes. It is fitting and proper that more thought than ever before be given to fire-control problems. Forest-fire protection is a recognized and direct part of the plan for total defense of the Nation.

Melis, in the preceding article, issued a challenge to all forest officers of all organizations to think of forest protection beyond the bounds of their own bailiwicks or protection zones—and to consider what changes of thought are necessary and what means will assist in providing Nation-wide forest-wide protection to the degree of refinement necessary.

Marsh, in his article, shows specifically what can be done in effectively mobilizing the efforts of small local grazing communities in eastern Montana—a cooperative job where all pitch in for the common good as at the old-fashioned "house raising." Klehm, along the Canadian border in Montana, in relating the story of possibly one of the worst lightning fire attacks recorded, graphically illustrates cooperation working at a high level of perfection in a grave emergency. Reading it, one pictures the enormous problem involved in planning for and carrying out cooperation on a State-wide or regional basis if the same situation had arisen over the broader areas.

Turning to the southeast, Cochrane relates the application of one of the principles of democracy—individual pride and dignity—to the fire-warden plan used in Virginia. Here again, planning and cooperation form the hub and axle of prevention and suppression. Then with the reading of Stone's article on municipal fire problems, as excerpted by Headley, of a city's fire defenses and the difficulties of the personnel managing them, a picture begins to form of the big task ahead of the Nation. Each of us plays a part in, and each of us can make some contribution of thought or action to the problem of National defense.

Writing this in January, some 3 months before it will be read, is difficult in these quickly moving times. However, it is evident that in some cases a reorientation of our thinking may be required, and in other cases a broadening of the base of our thinking and a quickening of our perceptions of needs and remedies may be in order. The formation of State fire-defense committees now under way may be a means of assisting in these changes.

COOPERATION IN FIRE SUPPRESSION

JOHN T. MARSH

District Ranger, Custer National Forest

Cooperation is basic to successful fire suppression. Without it the individual crew will not function properly nor will it be possible to obtain real coordination between units. Particularly is cooperation necessary when unorganized crews must be relied upon. In recent years the use of crews paid from various emergency funds may have caused many persons to forget the days when the district ranger relied largely upon the cooperative effort of local residents who viewed the fire-suppression job as a community project. More emphasis may well be given to the approach used by the author.

The eastern ranger districts of the Custer National Forest enjoy more widespread cooperation in fire suppression than most other portions of region 1. These cooperative efforts doubtless had their beginning before creation of the forest, when it was necessary for ranchers to band together for mutual protection against fires that occurred on their livestock ranges.

The situation on the Whitetail district is similar to that on other eastern districts of the forest. The principal use made of the national forest is for grazing of livestock. The ranch properties of the permittees enjoying grazing privileges are widely scattered within and adjacent to the forest boundary. Men are therefore available to take action on fires in all but a few isolated areas.

A fairly good communication system exists, which adequately serves most of the area. It consists of Forest Service and private telephone lines. Numerous so-called roads, visible as dim wheel tracks through the grasslands and open yellow pine timber, make the area accessible by automobile. Fire-tool caches are scattered throughout the forest at road intersections and centrally located ranches.

The local people are very fire conscious and it is rare that man-caused fires occur. After severe lightning storms the local people are on the lookout for fires in their vicinity. They frequently go to vantage points near their ranches to get a better view of the surrounding forest lands. When a fire is discovered the men drop the work at hand and leave immediately for the fire, picking up tools from the caches en route. Reporting the fire is usually the responsibility of the ranchers' wives.

Because of the prompt action by cooperators and the fact that the ranches are widely scattered throughout the forest, it is unusual for a member of the Forest Service organization to be the first to reach a fire. Additional tools, water, subsistence supplies, and overhead are furnished by the Forest Service. Manpower at the fire is rarely deficient. An increasing volume of smoke brings increasing numbers of men. Often 15 to 25 men will report at class A or class B fires, particularly if the fire is visible for a considerable distance.

How such close local cooperation is obtained is not easily explainable. The basic reason for it is doubtless the dependency of the cooper-

ators on the resources which fires destroy. The cooperators are grazing permittees, ranchers and employees dependent on the forest for timber. The Forest Service has had continuous business contacts with most of them over a long period of years.

Each rancher assumes responsibility for initial action on fires in his immediate vicinity. Where ranches are grouped, as in some of the larger drainages, the natural leader in that small community serves as per diem guard and takes charge of fires in the surrounding area.

The cooperative efforts in fire suppression have become a sort of community project. They offer a change in activity from the usual ranch work.

The ranchers are ambitious fire fighters and apply themselves to the job with a zeal rarely exhibited by other types of fire crews. Fire crews composed of such men do not require close supervision. Supervision can be handled almost entirely by suggestion.

When the fire is controlled, the men insist on taking a half hour of well-earned rest to talk over action on the fire, ranching and range operations, neighborhood gossip, etc. Such an abrupt let-up is rather disconcerting to one accustomed to handling ordinary fire crews. I believe it serves a valuable purpose and is also often enlightening to Forest Service personnel. The privilege is not abused, nor is there any intent of shirking the job. During the rest period, men occasionally leave the group to patrol and check on the more hazardous margins of the fire, without being specifically instructed to do so. When the group has had sufficient rest, they continue with the mop-up job.

The services of most of the cooperators are limited largely to the initial control period. It is the practice to release those that have urgent work at hand as promptly as possible. Volunteers are usually solicited from the group at the fire to complete the mop-up and patrol.

I believe that similar cooperation can be fostered elsewhere by impressing local people with their dependency on national forest resources. Mutual understanding and proper commendation for the part taken by the individual is essential. Throughout the job the cooperators should be treated in such a manner that they understand that they are doing the Forest Service organization a needed favor which is not demanded of them. This viewpoint or obligation on the part of the Forest Service organization is often more of a reward than the monetary payment for the services rendered. Respect for and appreciation of the other fellow's efforts are necessary in any sound cooperative effort.

THE KOOTENAI RECORD IN 1940

K. A. KLEHM

Forest Supervisor, Kootenai National Forest

One who has read of the work of the Air Raid Precautions personnel (A. R. P.'s) during the fires caused by the bombing raids in England, must have wondered at the problems of organization and cooperation involved. Here is an example of cooperation to meet a vital emergency—of cooperation of governmental units and of private organizations, all bending their efforts to meet the fire threat. Cooperation and planning is the basis for action such as is described here. If the number of fires had been doubled or trebled within the Kootenai and adjoining areas, what other forms and degrees of cooperation would have been necessary? What part can isolated local residents play in such situations? How can local thought and action be mobilized and guided?

The term "blitzkreig" as I understand it, means lightning war or action. It describes exactly the happenings on the Kootenai National Forest from 2 p. m. on July 12 until the same time July 25, 1940. The following table, showing by years the number of fires on this forest from 1931 to 1940 inclusive, not only provides a comparison but also gives a better idea of the situation:

Year	Lightning	Man-caused	Total	Year	Lightning	Man-caused	Total
1931	25	42	67	1937	15	25	49
1932	30	51	81	1938	140	19	159
1933	26	30	56	1939	125	30	155
1934	48	32	80	1940	427	24	451
1935	64	25	89				
1936	105	43	148	Total	1,005	321	1,326

The record shows that 34 percent of all the fires occurred during the summer of 1940; 350 or 77.6 percent of the 1940 fires occurred during the period from 2 p. m., July 12 to July 25. The number of fires by days follows:

July 12 ---- 86	July 17 ---- 11	July 22 ---- 13
July 13 ---- 55	July 18 ---- 35	July 23 ---- 5
July 14 ---- 14	July 19 ---- 3	July 24 ---- 3
July 15 ---- 23	July 20 ---- 55	July 25 ---- 3
July 16 ---- 20	July 21 ---- 24	

The number of fires by classes follows: 234 A's, 85 B's, 24 C's, 2 D's, 5 E's.

Area burned over in 1940: 4,445 acres.

Weather records show: A dry fall in 1939 with more than average moisture during the period from December 1939 to May 1940, with a deficiency during June and early July. Only one light rain fell from June 9 to July 15, and a heavier rain on July 27.

Lightning action starting fires means the same action for control. The Kootenai Forest has only one CCC camp and no improvement

construction crews of any kind. The forest is also located a long way from big centers of labor, such as Spokane or Missoula. Therefore, when the limited local sources of labor are exhausted, the regional office at Missoula is called upon for additional help when needed.

There are 8 ranger districts on the forest, 7 of which were hit. On one district alone there were 120 fires. The fires were scattered from low elevations in the valleys to the extreme elevations in the Cabinet Mountains, over a rugged area of 2,358,552 acres.

The forest had 2,400 men on fires by July 15. They arrived from far distant points—Butte, Anaconda, Miles City, Dillon, Billings, Missoula, Kalispell, Spokane, Lewiston, St. Maries, Sandpoint, and many other smaller places. They came by bus, trucks, and two special trains. Overhead arrived from Oregon, Idaho, Washington, and eastern Montana, coming by all types of conveyances including planes.

Numerous outside packstrings and trucks were employed in getting in fire camps and supplying this army of men in hundreds of places in rough country. Water had to be packed to several dry camps. One fire camp was put in by plane, and another dry camp was furnished with water by plane on two different occasions when the trail was blocked by fire.

Volumes could be written on what took place, including good and bad action. The main point is, however, that the unusual situation brought about on this forest by an outbreak of lightning fires was handled by an organization that could function to meet it. Cooperation within the organization, from the men on the ground where the fires occurred to those in higher positions, made possible success against what seemed insurmountable difficulties. No boundaries, either ranger district, forest, State, or regional, were allowed to interfere. The spirit was that expressed in, "We have a job to do, boys, so let's have at it."

[In addition to the cooperation of units and persons within the Forest Service, seen by Forest Supervisor Klehm, many outside agencies also cooperated. The regional office has given the following information:

Lumber companies supplied their crews and equipment in the usual manner. Transportation companies disrupted their schedules and generally gave fire control needs priority. Commercial radio stations cooperated in several ways, even to calling in trail crews for fire duty when there was no means of communication other than a commercial radio receiver. A telephone company furnished an operator who also functioned as an order clerk at a ranger station switchboard. Bus companies moved their equipment long distances and held it on standby, often with considerable financial loss. Grocery establishments loaned personnel to serve in warehousing capacities and a bank loaned men for timekeeping and accounts jobs. Many individuals also offered their services, from farmers with crops needing attention to former Forest Service employees, some living several thousand miles away.]

THE JEFFERSON WARDEN

ALLEN R. COCHRANE

Assistant Forest Supervisor, Jefferson National Forest

The striking results obtained through the use of the warden system on the Jefferson National Forest offer encouragement to forest officers who have need for the services of such a group of men and have been searching for a key to successful use of such a plan. Democracy itself is the keynote of the plan used in Virginia. Forest officers are servants of the public; through enlistment of the hearts and minds, as well as the bodies of the local men who serve as wardens, cooperation is obtained in fire protection for the general welfare.

The essence of democracy lies in the fact that all men possess dignity and pride as individuals. The validity of this assertion is accepted by the forest personnel on the Jefferson National Forest who regard it as an important statement in fire-control policy.

Fire prevention and suppression on the Jefferson is built around the warden system. The wardens are humble folk, mostly small farmers, owners of simple homes on the mountain farms lying adjacent to the national forest. It may have taken a rather deep faith in the democratic principle as stated to have started the warden system more than a quarter of a century ago. Probably it would be more nearly correct to state that it was a mixture of faith and desperation that inspired that start toward our present warden organization.

Appearances are very deceiving. The warden may be somewhat suppressed and denied economic advantages, but intellectually he is shrewd and possesses considerable ingenuity and originality. Every measure of faith placed in the men in the warden system has been justified by performance. In fact, the mistake has been that forest officers have not placed more consistent faith in this organization and the individuals which make it up.

When the new training systems came into being a few years ago, some doubt was expressed as to whether much could be done with adults set in their ways as these men were. Meetings, it was supposed, would be confined to amusement and entertainment with propaganda effect. Yet, some of the most successful training schools have been among warden groups, using conference and one-step methods. Some of the warden conferences have been outstanding for their instruction and inspiration.

Wardens as a group, lacking special training, are not outstanding for their judgment and technique in fire suppression. They are fairly reliable, however. Strangely enough, practically every device which has been developed recently on actual suppression methods has been used previously by some member of the warden group on the Jefferson. Unfortunately, the knowledge of the individual was not made common knowledge, and, for all practical purposes, did not exist. The one-lick method of fire-line construction has been used on occasions for years by numerous wardens. It was embarrassing

to discover this fact as did an instructor who thought he was springing something new. Warden C. C. Smith, living on top of the abruptly rising Alleghenies, described building a series of buffer lines to stop a fire on a steep hillside before the R–3 article was printed in Fire Control Notes. He had to do this to save his fences.

Some of our most unpromising men have made outstanding contributions to fire prevention. Doing a good job in their own local district without pay has added to their prestige as members of the community and provided an outlet for creative work. The work of a few outstanding men in fire prevention has justified all the time and effort expended by regular personnel on the organization.

No solution has been found for the slow average get-away time of a warden crew; gathering the men from their homes, the fields, and church on Sunday is time-consuming.

Forest officers appreciate the intelligence and ability of the wardens in fire prevention and meet them as equals. They assume that the wardens are glad to have new ideas presented, and solicit their opinion on how a better job can be done.

Good wadens are the answer to effective fire prevention in Virginia and perform a real public service. They know that the small contributions of individuals, when added together, make a impressive total. Each man is another "head power," and the Jefferson is plus 100 head power instead of 10 or 15 head power, which would be the case if the wardens were not considered as an integral and basic part of the organization and their opinions solicited on practically every phase of fire control.

FIRE INSURANCE CLASSIFICATION OF CITIES AND FIRE LOSSES

ROY HEADLEY

Fire Control, Washington, D. C.

Students of the financial management and economics of forest-fire control naturally turn hopefully to the elder brother, municipal fire protection, for pertinent ideas, methods of analysis, and tested ways of thinking. The result of such a quest is disappointing. Considering relative values, losses, and potential resources for searching study in forest-fire control as against municipal protection, forest-fire men need not feel apologetic about the fact that their thinking has advanced so little. A real start has not yet been made in either field, although it does seem that municipal management should have felt a stronger urge toward a serious attack on the subject than exists in forest-fire control management.

However, despite his disappointment, a forest-fire man can glean some things of interest and suggestive value from municipal protection literature. One of the more searching recent studies is by Harold A. Stone, published under the above title as a 25-page pamphlet, by the Public Administration Service of Chicago. The following excerpts will be of interest to forest-fire men.

Foreword

The fixing of fire-insurance base rates for cities affects municipal officials and taxpayers vitally. Here is one field of governmental service where public spending and private saving are obviously and clearly related. If the appropriation for fire protection is decreased so as to lower the city's classification, as set by the National Board of Fire Underwriters, the immediate result is to increase far beyond the tax saving the amount of premiums which taxpayers must pay.

Officials seeking legitimate economies in governmental costs find on the one hand that the fire insurance authorities are constantly demanding expenditures for mains, hydrants, and other physical equipment under pain of raising insurance rates; while on the other hand, the Board of Underwriters has taken a leading role in the campaign for tax reduction. And while the National Board of Fire Underwriters has painted vividly the blighting effect of taxes, the National Fire Protection Association has warned the public of the dangers of skimping on appropriations for fire protection.—Foreword by Charles S. Asher, director of publications.

Ability to Use Fire Defenses

As mentioned earlier, the basis of spreading insurance within a State, i. e., distributing losses, is the classification of cities set by the National Board of Fire Underwriters. This classification is based upon fire defenses and physical conditions; in other words, weapons. No consideration in grading a city is given to the loss record, to the moral hazard, and practically none to ability to use the weapons. Perhaps the omission of these factors will explain the lack of relation-

ship between fire losses and defenses (classification) pointed out at the beginning of this monograph. These three factors will now be analyzed, with attention first to the city's ability to use its fire defenses.

A long-established axiom tells us that a skilled carpenter having excellent tools will do a better job than an unskilled worker with the same tools. Thus, it can be said that the city's ability to use fire defenses lies in the skill of the personnel employed. If the firemen are well trained and have achieved facility in the use of equipment, the chances of coping successfully with a fire are obviously much greater than with an untrained, fumbling company of men.

The National Board of Fire Underwriters gives some consideration to the ability of the personnel to fight a fire. Out of 34 elements considered in the schedule under the heading "Fire Department," the following 7 touch upon the subject of competency: Item 7, Operators; Item 3, Qualifications of Chief Officers; Item 5, Appointment and Promotion of Officers; Item 6, Enlistment and Promotion of Privates; Item 28, Regulations and Discipline, Item 29, Drills and Training, Item 31, Fire Methods. Although this is an imposing list of factors, nevertheless no consideration is given to the officer's "fire sense"; that is, his instinctive ability properly to size up a fire, to lay plans quickly to save the occupants and contents, to prevent its spreading, and to extinguish it. Generalship on the part of the officers is another element omitted in the ratings of the fire department. Hydraulic and engineering knowledge of hose streams, pumps, chemistry of a fire, ventilation, strength of materials, and a score of other elements are left out. The Los Angeles department is one of a few having a training school or college for the continual instruction of the old-line fighter as well as the recruit. Most departments seem to leave any quest for knowledge to the initiative of the men.

Rating Actual Performance

It is the author's belief that the factors of actual performance and skill are at least as measurable as some of the items now included in the standard schedule. Measurement tests of this character have been developed in the field of public administration since the standard schedule of the National Board of Fire Underwriters was promulgated. It is entirely beyond the scope of this brief study to detail the manner in which such tests should be adapted to the appraisal of fire departments; but it seems fair to conclude that the failure to include the elements of skill and ability to use defense weapons in rating a city is one answer to the question, Why are the losses in one city so much higher than in another when both have the same classification? There may be other reasons, now to be discussed.

Moral Hazard

Many explanations are advanced for the low fire losses in European cities. One of them is the absence of what is called in the United States the "moral hazard." It is the flippant, "I-should-worry" attitude of individuals who flagrantly violate fire laws. If it is generally absent in Europe, it can be eradicated in the United States. In fact, "moral hazard" varies considerably between cities, as a pre-

vailing public consciousness of the dangers of fire has been cultivated in a number of cities. Thus, in Fresno, Calif., where a successful attack was launched against an unusually large number of fires, one of the methods used was a continuous educational campaign—not merely spasmodic efforts—culminating in "Fire-prevention Week" once a year.

Carelessness accounts for most of our fires. Fully half of them can be so classed. They are preventable, but no reduction in the number will be brought about until the "moral hazard" as gaged by the prevailing attitude of the inhabitants of a municipality is placed upon the same plane as in European cities.

Fire Prevention

Until recently, Kansas City, Mo., had one of the highest fire losses among large American cities. Moreover, it was consistently high, year after year. After a detailed study had been made by the Insurance Committee of the Chamber of Commerce the city got busy. The report said, "This exceedingly bad record furnishes a local condition which may be remedied only through increased fire-prevention work." Now Kansas City losses are much less, largely through persistent fire-prevention activities. Fresno, Calif., beginning in 1927, scored an excellent achievement in ending one of the worst continuous fire-loss experiences in the country. It conquered the trouble by a well-managed bureau of fire prevention, staffed by skilled engineers. Cincinnati has achieved the same result.

In his book on fire prevention Mr. Stone concluded, "There is a growing realization that fire-fighting units of the larger cities and in a great many of the lesser-sized municipalities have reached what may be termed their "marginal utility." This applies not only to fighting fires of conflagration proportions, but also to the upkeep and cost of the fire-fighting organization. Therefore, future progress and relief from the situation must be in another direction, viz, fire prevention."

Conclusions

Only one conclusion can be reached from the data and analyses presented in this study. Although a definite correlation should exist between the classification of a city set by the National Board of Fire Underwriters and the losses and number of fires in that city, no such relationship exists. There is as much chance of a good record with what the National Board of Fire Underwriters calls poor fire defenses as with what it rates as excellent ones. This statement was made at the beginning. It holds after a critical examination of the factors tending to throw doubt on it. Are insurance premiums being loaded on to people having small losses so as to pay for the carelessness of others having heavy losses? Insofar as the grading schedule is used as the basis for establishing rates, the answer must be yes. A city with a good classification and high losses is not always paying its fair share of the cost of insurance. Conversely, a city with an excellent record of losses, but burdened with a poor classification, may be unjustly paying for the carelessness of someone else.

Four Factors Omitted

There are at least four factors which we have attempted to show should be considered in the classification of a city, the omission of which undoubtedly accounts for the present discrepancy between classifications and fire losses. These are: (1) The ability to use fire defenses, which is a matter of personnel; (2) fire prevention; (3) moral hazard; and (4) the record of fire losses and number of fires. The argument for not including these factors in the grading schedule now used by the National Board of Fire Underwriters is that they are imponderables, not subject to exact engineering measurement like the elements now included in the schedule. It is our belief (although it has been beyond the scope of this analysis to elaborate the point) that some, at least, of these factors are as measurable as items now on the schedule, in the light of measurement techniques developed since the schedule was framed.

Schedule Alone Not Enough

But even if this be disputed, the clear inescapable fact remains that if these elements are not taken into consideration, the classification does not give a fair picture of the city's ability to cope with fire as shown in the actual record of fire losses and number of fires. The conclusion may then be that the elaborate engineering appraisal, summarized in the deficiency points established by the grading schedule, should be only one of the factors used in fixing the base rate for a city. Some evidence has been presented to show that in practice the authorities do give weight to other factors. If this is to be done, it is our plea that it be done openly so that public officials and the payers of taxes and insurance premiums can see how the base rate of their city is determined.

THE ARMY ON FIRE FIGHTING

AXEL LINDH

Fire Control, Region 1

The education of an individual does not come entirely from within his own personal experience. Man profits by the accumulated experience and wisdom of his group or society. So also, a profession draws when it can from the knowledge acquired by other professions. In this article a parallel is drawn between some of the tasks confronting one of the oldest professions with that facing one of the youngest.

A planner of Army strategy and tactics—Lieut. Col. Joseph M. Scammell—writing in the Infantry Journal for January 1941, might have been describing the fire suppression problems of region 1 in the following quoted from his article:

"Thus we see our ideas of 'normal' warfare are no safe guide. Time and space factors used in staff calculations must be radically revised; and even then may prove misleading because conditions are so uneven. The kind of instruction now given may be an actual handicap rather than an aid, except as regards principles and methods. Troops that on level ground move at 3 miles an hour and develop for combat in a few hours, at high altitudes will have to rest frequently and will move with excruciating slowness. The column, moreover, will be strung out for miles and will have to close up. An attack once launched will progress slowly, especially in the absence of strong and effective supporting fires and the necessity for maneuver. The coordination of arms will not be easy to secure. The approach, the development, and the attack will seem like a moving picture run in slow motion.

"The requirements of mountain warfare are a direct challenge to our organization, tactics, supply system, and above all the rigidity of the methods by which we select leaders of units especially in high commands. In the absence of special formations and special training, only a leader endowed with great flexibility of mind, of sound military judgment, and of independence of character can hope to succeed. He must have an appreciation of terrain and a strong sense of time and timing. He must be able to throw away his formal instruction. He must discard preconceived notions of concentration of force, discard the existing organization, and wage war with small, isolated columns. Superiority in numbers, in fire, or by surprise can be achieved only by making use of every possible avenue of approach, especially those which are 'impractical' and 'impossible.' * * *

"Nowhere else as well as in mountain warfare do small units exercise such decisive results. Only by maneuvering against flanks can success be brought about. The usual avenues of approach are blocked and swept by defensive fires. Only small units can climb like mountain goats and worm their way up, over, and through to a flanking position. Boldness, initiative, endurance, resolution are necessary. Even during the approach march these small bodies are indispensable; for the routes by which the larger bodies must advance usually run in defiles; and it

is necessary to occupy the heights above before a column dare venture ahead. Mountain warfare is a game for young, strong men, with young, bold, and resourceful leaders. Mountain warefare is light infantry warfare to a superlative degree.

"Those who can wage war in the mountains, deserts, and jungles, can make war anywhere. But the reverse is not true. It is in minor warfare that we find the true test of generalship and the true training of soldiers."

Why Do Ideas Grow in Such Erratic Ways—From 1910 to 1935, creative thinking about organization for fire suppression confined itself largely to organization of facilities for feeding men and the division of fire-fighting jobs into zones, divisions, sectors, etc., corresponding to certain supervisory functions. Every effort to draw attention away from departmental and camp organization questions met with failure, despite the fact that actual production on line was notoriously low and the further fact that the best camps and overhead organization charts meant nothing unless they affected production on line. Creative minds clung to questions about the proper location of the cream and sugar table and how many sectors should be included in a division.

But times have changed. There is now a trend of thought which holds that our glorified camps are out of harmony with the nature of the job and due to pass on with the dinosaur. Delivery of cooked food by air or otherwise to workers wherever they may be at eating time is beginning. For a 72-hour job the 40-man crew is independent of any camp for either beds or food. And with respect to organization and management on line, ideas are sprouting in every direction. Experiments small and large are being made in many places. And why not? Here is an exceptional chance for the man who likes to think about better ways of doing his job. The district ranger who gets a new idea may have the fun of testing and developing it without having to persuade anyone that he should have a grant of funds for the purpose. If the Forest Service is to become really expert in construction, line holding, and mop-up, it must first pass through a stage in which scores of distinctive methods are under test—each the invention of some active minded man or group. It looks as if we are on our way to that wholesome stage of growth.

In 1935 when Kenneth P. McReynolds began experimenting with the long known but dormant one-lick scheme of organization and management on line, he must have broken the drought of ideas on the subject. At any rate, 5 years later we have a promising number of ideas and methods in circulation. In addition to the antique "man-passing-man" method and the individual assignment and one-lick methods, we now have the distinctive White Mountain 10- to 15-foot variation of the one-lick method, described in the July 1940 issue of Fire Control Notes; the Austin Rotary method described in the same issue under the title of the "Spinning Fireman Methods for Grass Fires," and in the October 1940 issue; and the progressive step-up method also described in the October issue.

In response to some pressure, Otto Lindh and Larry Mays admitted at the Ogden meeting that they had invented the germ of an idea for using the one-lick or progressive principle for line holding and patrol, as well as line construction. If this proves workable in practice, it will solve some acute difficulties which arise when line is constructed rapidly. It might in time turn out to be one of the major developments in organization for fire-fighting.

All of the foregoing developments are apart from the unified organization and management of men and machines which is a large field by itself. For too long, men were managed on a fire in disregard of any machines present, and, in turn machines were used as if there were no men around. Even in 1939 it was possible to see a hand-tool crew following a tractor-trail builder and making a silly little hand trench in the middle of the tractor made trench—just as hand-tool crews used to obliterate a perfectly good horse-plow furrow. But a creative trend is setting in toward a unified and coordinated use of men and machines. Not much has actually been accomplished yet, partly because machines have too often been unreliable. But the possibilities are very large. They invite the attention of men of inventive ingenuity.

These contributions to the management of fire suppression should hasten the day when western production of held line will pull up out of the bracket of six to sixteen hundredths of a chain per man-hour and eastern production will climb to Supervisor Bryan's standard of 6 chains per man-hour.—ROY HEADLEY, *Division of Fire Control, Washington, D. C.*

AN ASPECT OF THE FIRE-CONTROL JOB

ROY A. PHILLIPS

Forest Supervisor, Nezperce National Forest

Management and coordination of men and equipment is a field of fire suppression which is growing more difficult. With mechanical aids to suppression have come problems of training in the use of specialized equipment. Of greater difficulty is the problem of training personnel in the wise and timely use of such equipment—the coordination of manpower with equipment so that each will be used in a way which will best advance the total job to be accomplished. Even some of the management aids themselves, such as radio and telephone, bring problems for solution. A forest supervisor draws upon his 30 years of service in focusing attention upon this bugbear. He gets down to specific cases and finally proposes personal energetic action on his own unit.

That "necessity is the mother of invention" is an old proverb and a true one that sometimes applies to fire-control action and methods as closely as to other things.

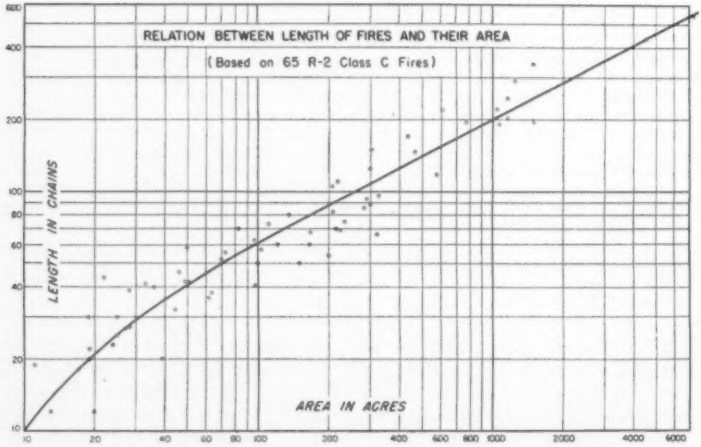
In 1914, as a ranger on the Lolo Forest, through the force of circumstances I commandeered a stumprancher's plow and team and saved the day of a 4,000-acre fire. In 1930 a 200-acre fire in a high alpine timber type in bug-killed timber threatened to leave the country, and this time the day was saved by getting a plane to drop a dozen back-pack pumps from the air. Many times I have used the one-lick, step-up, and other variations of line-contruction methods in emergencies when manpower was short and the situation critical. Many other men throughout the Service must have had like experiences, and I wonder if they feel as I do that we have failed to a very considerable extent to capitalize on them.

Take the horse and plow as an example. It is a poor one, I must admit, as the average forest officer uses a horse very little these days when high-powered motor cars are available to everyone and gasoline scooters are being seriously considered for trail travel. But old Dobbin still has a lot of potential value for fire-line construction if we can get men who can handle a horse and plow. A good horse-plow unit is equal to 25 to 50 men in any man's country, and it packs in to the fire line its initial needs for 1 day, and each following day requires only 60 pounds of hay and oats as compared to many times that weight of tools, mess equipment, food supplies, and beds needed for the manpower it represents.

Practically every piece of equipment and every fire-fighting method that has been developed over the years has a place on any large fire. Yet how often do we see plow horses tied up in camp eating their heads off; Bosworth trenchers standing idly by while men dig trench by hand; men clearing line and digging miles of trench when a few back pumps and a little water would do the job; pumpers set up and a lot of men dragging hose around, using thousands of gallons of water when a few hand pumps and a little water might do as much good; men standing idly by or in each other's way

because the work methods are bad or the work poorly organized.

All these things and many more we see on any large project fire, yet what are we doing about it? When I see such a situation on the ground, I do the best I can to straighten it out, just as any other fire boss would do, and I set up a mental promise card to do something about it in the future. But somehow that something never reaches the degree of accomplishment that is expected.



Relationship between length of fires and their area.

I have decided that there is something wrong with our training methods, and this year we are going to do the job as we have never done it before. A horse-plow unit will not go to a fire unless there is a trained crew to handle it—a trained crew built around a 50-man unit that will go to a fire intact and operate in that fashion. The same thing will be true of the Bosworth trencher and other items of equipment. Men will be trained to fight fire systematically and in such a way that there will be no interference or confusion. The system may not be new or have a high-sounding name, but it is going to be efficient. We may not get much done but training, but we are going to do that. And if force of circumstance throws a green or poorly trained crew on to a fire, special overhead will be provided to see that that crew gets systematic training from the time it hits the fire line until it leaves. We all know that the most valuable training of all takes place right on the fire line, but we haven't been able to find the time to do it. From now on we are going to take time.

With each succeeding year becoming more dry and the forest cover more inflammable as a result of insect attacks, disease, and a natural accumulation of forest debris it is imperative that we use every resource at hand to combat the fire menace. Every method and piece of equipment developed and proved should be used, and it is essential that the organization keep alive to the development of new methods and equipment and train men to use them. At the present time there is greater need to look forward to the future rather than to the past than at any time in our history. And this holds true particularly of our fire-control job.

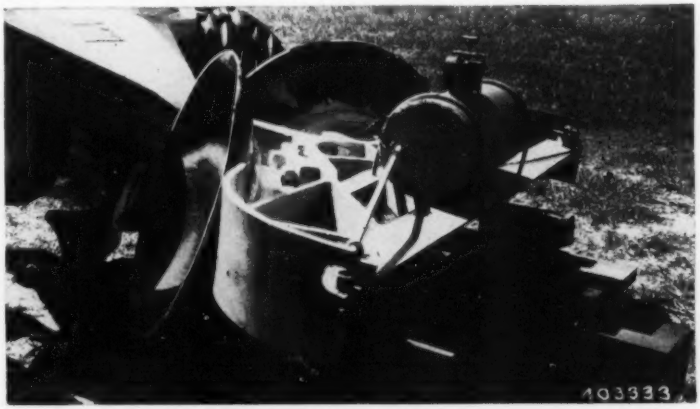
FLORIDA'S ONE-MAN FIRE "CREW"

DONALD J. MORRISS

District Ranger, Osceola National Forest

Mechanical equipment to control fires is a subject which intrigues most men responsible for fire control. The suppression plow is no exception. Here the addition of a backfire attachment has entirely changed the ideas of satisfactory fire-line production in certain flat country of the Florida national forests. Records of actual use will be awaited with interest.

As his special contribution to the Southern States' fire-control meeting recently held at Camp O'Leno, near Lake City, Leon Mathis, proprietor of the Mathis Welding Co., Lake City, Fla., added a backfiring attachment to his suppression plow. One of these attachments has been purchased for use on the tractor plow outfit on the Osceola National Forest.



Mathis plow with back-firing attachment.

The equipment described consists of a small high-compression tank and pressure gage mounted on the rear cross member of the plow, with metal lines to each side. In operation the tank is partially filled with gasoline, then air is added to 100 pounds pressure through a built-in valve. The air-gasoline mixture may be released through a small orificeon either side of the plow, and when igniated produces a flame from 3 to 6 feet in length (depending on need and controlled by a valve on each line). A small cup stuffed with lamp wicking immediately beneath the orifice relights the gasoline flame if it blows out.

On several trials one man drove the outfit, and by himself controlled a small fire. In ordinary use, of course, additional men would be necessary to hold the backfired line.

The entire outfit operates as follows:

A rolling coulter cuts the sod and small roots. Behind the coulter a middle buster opens a furrow which is widened by a disk on each side and immediately behind it. Following the disks a flange on each side prevents the sod from falling back into the line. Through holes in these flanges the flame from the backfiring attachment shoots out into the grass. The result is a clean line about 2 inches deep by 4 feet wide, automatically backfired.

Front view of Mathis plow with attachment.

The plow (which is mounted on rubber tires) is trailed behind the truck carrying the tractor. It is planned to keep this outfit in the woods with a small road crew during the coming winter, and to dispatch it by radio to each fire.

The type of small suppression plow to which the backfiring equipment is attached has been used experimentally by the Florida national forests for the past 2 years. It has proved to be our most valuable piece of fire equipment and has now been made standard equipment on this group of forests.

FIRE HAZARD REDUCTION, AN INSTRUMENT FOR DESIRABLE FOREST PROTECTION AND MANAGEMENT

NEAL D. NELSON

Coeur d'Alene National Forest

Estimating the possibilities of fire in a particular area and then balancing the cost of desirable hazard reduction or other protection costs against the damage if a fire should occur is one of the difficult problems facing a manager of forest lands. In this article a forest manager discusses some of the factors which led to the decision to remove the hazard of a 1929 burn—an unlighted torch in the midst of a large area of valuable white pine virgin timber. Procedure in the reduction of the hazard by burning and the costs for the operation are given.

On a late August day in 1929 a passing lightning storm left in its wake a number of fires, three of which quickly spread to class C size. One of these fires on the Flat Creek drainage of the Coeur d'Alene Forest burned timber of the 200-plus age class. The composition of the mature stems of the stand by volume was as follows:

	M. ft. b. m.
Western white pine	1,495
Western larch	114
Douglas fir	80
Grand (white) fir	236
Western hemlock	322
Western redcedar	11
Lodgepole pine	3

The general exposure of the area is north to northwest. The elevation ranges from 2,900 to 4,100 feet, with slope varying from 10 to 90 percent. The soil is composed of shaly loam with protrusions of igneous rock.

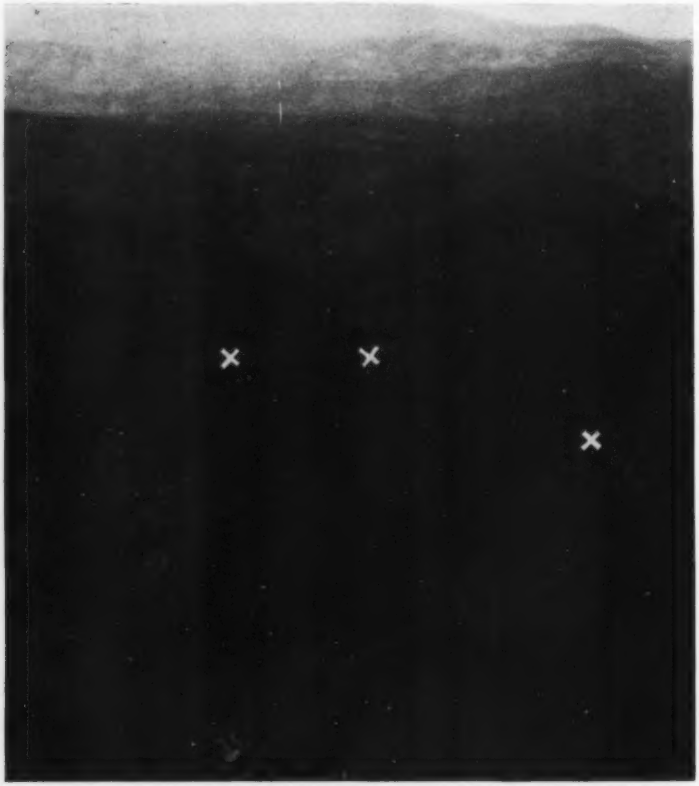
Unburned in the Flat Creek drainage there is now approximately 32,000 M ft. b. m. of merchantable western white pine. Within a circle of a 5-mile radius centering on this burn is an additional 120,000 M ft. b. m. of white pine exclusive of that lying in the Flat Creek drainage. There is a still greater volume of other species.

The merchantable white pine is being held in reserve in order that sustained yield may be practiced. Under the forest management plan the first sale is scheduled for 1949. Unless something occurs to upset the management plan some merchantable white pine will remain uncut 20 years hence.

The location of the burn, which was composed of "High high" fuel type, was such as to cause constant concern throughout the fire season. (In the fuel-type classification used by the Forest Service "High high" means high rate of spread and high resistance to control. The area surrounding the burn is generally that classed as "Medium medium" and "Low medium.") With lightning occurrence high in the general area during the past decade the burn stood as a constant threat to areas of valuable merchantable timber about it. Including all white pine timber within a 5-mile radius, it is estimated that there are values

of at least $600,000, exclusive of other species, stumpage based on $4 per thousand. It was, therefore, considered worth while to reduce the hazard on the 291 acres burned.

Plans were made for accomplishing the hazard-reduction work. A nearby CCC camp dropped the snags on the area during the winters of 1937–38 and 1938–39. A fire line was constructed to a width of 20 to 50 feet, depending upon the degree of slope and adjacent fuels. All



A-59, COURTESY OF 116TH PHOTO SECTION, WASHINGTON NATIONAL GUARD

Looking west up Flat Creek drainage.

preparations prior to burning were completed by early September 1939.

While the preparatory work was being performed the burning job was being carefully planned. The burning of the area took place during the latter part of September 1939. As a result of the study made it was deemed advisable to burn the area in two separate pieces, the smaller area consisting of a small draw at the upper limits and running at right angles with the main body of the area to be burned.

Personnel participating in the burning was on the ground at noon of the day the burning was to take place. Plans were discussed fully with all supervisory personnel so that each man understood his duties

and responsibilities. The men had an opportunity to rest so that when the burning started in late afternoon they were sufficiently rested to be able to cope with developments.

Fires were first started at the top, and burning progressed downhill until approximately one-third of the area had been set afire. The setting of the lower edges was withheld until the upper portions had been burned sufficiently to act as a buffer for the fire running uphill. The ranger in charge, in order to have command of the situation, installed three telephones at strategic points on the fire.

The resulting burn consumed all the fine fuel, burned a portion of the stems, but left the boles of some of the larger trees. Aside from the few unburned stems and stumps, all material was consumed to mineral soil. As in former controlled burns the heat generated by the burning of the lower two-thirds of the area was so intense that only through constant vigilance and the use of pumps was it possible to keep opposite hillsides, composed of mature green timber, from catching fire. Especially was this true in terrain of steep, narrow canyons.

From a forest-protection and timber-management standpoint reduction of such hazards are worth while undertakings. Not only was the danger from fire decreased, but control of white pine blister rust was facilitated. By the elimination of the fire hazard, ribes bushes, as well as stored ribes seed in the duff, were destroyed. Very few are expected to establish themselves on the area. A very expensive and almost impossible control job has been converted into a minor problem.

The area was left in an ideal condition for reforestation. The majority of the area was planted to western white pine during May 1940, the remaining 35 acres being planted in September 1940. Results obtained from the spring planting by examination in October showed 83 percent survival on the area, or an average of 684 white pine seedlings per acre as contrasted with a poor stocking of larch, white fir, and hemlock previous to the treatment.

The costs of the work in man-days was as follows:

4,510 CCC enrollee man-days felling and slashing.
878 CCC enrollee man-days construction firebreak.
250 CCC enrollee man-days burning.
260 CCC foreman man-days felling and slashing.
54 CCC foreman man-days construction firebreak.
30 CCC foreman man-days burning.
30 temporary guard man-days burning.

For the complete job 18.7 CCC enrollee man-days per acre were used, 1.2 CCC foreman man-days, and 0.1 temporary guard man-days.

The cost for the 291 acres was high. The removal of the high hazard, however, affords greater opportunity to practice good forest management. The threat of having to sell several million feet of timber because of fire kill has been reduced to a minimum. It is now possible to proceed with the forest management plan with assurance that it can be followed through without being disrupted by fire. Disease control has been facilitated and the area has been reforested to the most desirable species of tree in the locality. The cost of the job, when compared with the full benefits derived, is of minor consideration as the results have contributed much to the sustenance of a valuable forest resource, to a stable industry, and the economy of neighboring communities.

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MAN-HOURS OF WORK REQUIRED TO CONSTRUCT VARYING LENGTHS OF LINE UNDER DIFFERENT RESISTANCE-TO-CONTROL CLASSES

E. Arnold Hanson

Fire Control, Region 4

Computations and estimates of probable size of fire and the number of man-hours needed to catch up with and control a fire which has gotten out of hand are fraught with "ifs." The original decisions of a fire boss as to manpower needed to suppress a particular fire before a certain time has elapsed involve estimates of rate and direction of spread to be correlated with estimates of rate of line construction by the men available within the same period of time. The author presents a method of checking the results of such estimates by working backwards from the probable acreage the fire will attain. Though there may be question as to the adequacy of the sample upon which tables 2 and 3 are based, the approach seems to have distinct value. Further study will no doubt add to our knowledge in this field.

Believing that appropriate tables or reliable rule-of-thumb methods for estimating the number of man-hours of labor required to construct varying lengths of control line would serve a useful and advantageous purpose, the author made a statistical study designed to determine for conditions in region 4:

1. Relationship between total acreage of individual fires and total chains of control line built on these fires.
2. Rates of line construction in chains per man-hour under different resistance-to-control classes.
3. Man-hours of labor necessary to construct varying lengths of control line under different resistance-to-control classes.

The tables and rules of thumb developed were included in the 1940 amendments to the R–4 Fire Control Handbook and were discussed at the overhead training camps held in May 1940. The general opinion was that most firemen think first in terms of acreage, subsequently in terms of perimeter; and that the data would be helpful as a guide to the estimates of the dispatcher, but more especially to those of the fire boss, where airplane reconnaissance in the early stages of a blow-up fire furnishes the basis not only for accurately estimating acreage at the end of the first burning period, but also the character of the fire, i. e., whether clean, compact exterior, spotted condition, etc.

During the 1940 fire season a few field men applied the figures developed with satisfactory results.

The study is based on data accumulated prior to the advent, in region 4, of the modified one-lick method (also referred to as 1-minute method and step-up method). Consequently, whenever this method of line construction is used, the tables will give too high an estimate of the number of man-hours necessary to control a fire. It

is planned to revise the estimates downward as soon as sufficient data on rates of line construction with the modified one-lick method become available.

Relationship Between Acreage and Control Line

Table 1 shows the average number of chains of control line built on fires of different sizes. The basic data were taken from the coded individual fire reports and cover B and C and larger fires which occurred during the period 1934 to 1938, inclusive, on the 7 Idaho fire forests—the Boise, Idaho, Payette, Weiser, Challis, Salmon, and Sawtooth. A total of 140 fires was used in the correlation study which resulted in the curve shown in chart 1. The equation for this curve is:

$$\text{Log } Yc = 0.574 \text{ Log } X + 1.003,$$

wherein Yc represents chains of line, and X final acreage of fire. The correlation coefficient was 0.894, very highly significant, and the standard error of estimate was 0.24554, which is in terms of *logarithms*. Of all observations, 16 percent will fall above the upper broken line and 16 percent below the lower broken line.

Table 1 was constructed by using the equation stated. The direct results appear in the table under the heading "Average" and are printed in italic. The figures in the "Maximum" and "Minimum" columns were obtained by calculating "Yc" for "plus one standard error" and "minus one standard error," respectively.

Rates of Line Construction

Table 2 shows the average rates of line construction in chains per man-hour, under each of five classes of resistance to control. These figures were obtained by an analysis of the rates of line construction on 28 class C and larger fires which occurred on the same 7 Idaho forests during 1939. These were the only reliable data immediately available for study.

The rate of line construction, in chains per man-hour, was taken directly from the Form 929 reports. These figures were then arranged in increasing order, from 0.06 to 4.50 chains per man-hour. A 100-point uniform scale was laid off as the X-axis on a sheet of cross-section paper and the rates plotted on the Y-axis. Since there were 28 observations, each one represented about 3.6 points on the 100-point scale.

Observation of the plotted points indicated a straight-line relationship to about point 65, and a curvilinear relationship from that point to 100. Accordingly, two equations were calculated and the curves plotted as shown in chart 2.

The equation for the data from 0 to 60 is:

$$Yc = 0.002{,}906\ X + 0.055{,}439.$$

The correlation coefficient is 0.978, very highly significant, and the standard error of estimate is 0.0128. For the data from 60 to 100, the equation is:

$$10\ (\text{Log } Yc) = 1.798{,}533 + 0.034{,}157\ X.$$

The correlation index is 0.859, also very highly significant. The standard error of estimate is 0.227, which is in terms of *10 times the logarithm* of *Yc*, due to coding.

The resistance-to-control classes were set up arbitrarily by dividing the 100-point scale into five equal parts. This is where an important assumption enters the study.

In setting up these resistance-to-control classes it was necessary to assume arbitrarily that the average rate of spread for each class is a reliable index of resistance to control. When topography, fuel type, fatigue, etc. are considered together as constituting resistance-to-control, this assumption does not appear unreasonable.

Man-Hours of Labor Necessary

Table 3, showing the number of man-hours necessary to construct varying lengths of control line, was constructed from table 2 by mathematical methods. For example, table 2 shows the average rate of line construction in the medium resistance-to-control class as 0.20 chains per man-hour. To build 100 chains of line then, the number of man-hours required would be 100 divided by 0.20, or 500 man-hours. The figure shown in table 3 is 498 man-hours because 100 was divided by 0.2007 instead of the rounded 0.20. The balance of the table was built in the same manner.

Use of the Tables

As an example of how to use the tables, assume that a fire boss has arrived on a fire with 10 men. After carefully observing the physical factors, such as topography, fuels, weather, time of day, etc., he makes an estimate of what the probable acreage of the fire will be by the time he can build the line necessary to control it. Perhaps he estimates 200 acres. Needless to say, this step is most important and requires sound and experienced judgment.

Then, by referring to table 1, he obtains an estimate of the number of chains of control line he will have to build, in this case 211 chains, or say 200. He can obtain this figure either from the table directly or from the rule-of-thumb which was developed by inspection of the tabular values.

Next, by roughly classifying the line job as to the class of resistance to control, considering all pertinent physical factors, he enters table 2 and obtains an estimate of the rate of line construction reasonably to be expected. Assume he estimates the class to be medium; table 2 shows that he can expect about 0.20 chains per man-hour. This particular item is not necessary to enter table 3, but is for his own information.

Now he is at the point where he has estimated the probable acreage to be 200 with 200 chains of line to be built under medium resistance-to-control conditions. He then enters table 3 and opposite 200 chains, under "Medium," he finds 997 man-hours as the estimate of the size of the job. For convenience, call it 1,000 man-hours. If it is intended to work men on a 10-hour shift, 100 men will be needed to bring the fire under control in 10 hours. He has 10 men, so he orders 90 more.

Or, say they are to be worked a 12-hour shift. By simply dividing the number of man hours (1,000) by the length of the shift (12 hours)

he can obtain a close estimate of the number of men he will need, in this case 83.

Table 3 gives man-hours rather than number of men in order to provide this flexibility.

Discussion

In connection with the practical applicability of these tables, there are several points which should be borne in mind. One of the most important is that table 1 shows the number of chains of control line which have been built on fires of different sizes. The table is based on 140 actual cases and should be reliable. However, in order to obtain an estimate of the job size the fire boss must estimate what the acreage of the fire will be by the time he thinks it can be controlled. This is a weak point, but is exactly what fire bosses have always had to do. From this point the tables give a fairly accurate estimate of the number of man-hours necessary to control the fire.

Another point to bear in mind is that tables 2 and 3 are based on only 28 cases, the class C and larger fires of 1939. This is a small sample. However, the known range of rates of line construction is present. Therefore, it is legitimate to assume that the sample is adequate and representative.

The division of the 100-point scale into five equal parts as resistance-to-control classes is open to criticism. The main argument in favor of a nonuniform scale is that the proportions should correspond closely to actual conditions. For example, of the 28 cases used, 5 fall in the "Extreme" resistance-to-control class, and either 5 or 6 in each of the other classes. We know, however, that most of the observations should fall in the "Medium" class.

The reason for using the uniform scale is that reliable data were not immediately available for properly delineating nonuniform classes. Actually it can be seen from chart 2 that if nonuniform classes were used, the average rates of line construction, table 2, would be smaller than those tabulated. This would have the effect of increasing the number of man-hours in table 3.

Consequently, it is apparent that use of a uniform scale results in more conservative estimates than would otherwise have been the case.

TABLE 1.—*Acreage of fire and control line necessary*

Acreage of fire (acres)	Control line necessary to build (chains)			
	Minimum	Average	Maximum	
10	21	*38*	66	RULE OF THUMB
20	32	*58*	99	1. Class B fires—4 chains perimeter per acre.
50	54	*95*	167	2. Class C fires—2 chains perimeter per acre.
100	80	*143*	249	3. Class D fires—1 chain perimeter per acre.
200	120	*211*	371	4. Class E fires—½–1 chain perimeter per acre.
300	151	*266*	468	
400	178	*314*	552	
500	203	*357*	628	
600	225	*396*	697	
700	246	*433*	761	
800	265	*467*	822	
900	284	*500*	879	
1,000	302	*531*	934	

NOTE.—This table can be extended without serious error.

TABLE 2.—*Average rates of line construction*

	Resistance to control								
	Extreme	High	Medium	Low			Very low		
				Minimum	Average	Maximum	Minimum	Average	Maximum
Chains per man hour	0.08	0.14	0.20	0.23	0.39	0.66	1.22	1.89	3.18

TABLE 3.—*Man-hours of work needed to construct varying lengths of line*

Control line necessary (chains)	Resistance to control									
	Extreme	High	Medium	Low			Very low			
				Maximum	Average	Minimum	Maximum	Average	Minimum	
25	296	175	*125*	108	64	38	21	13	8	Rule of thumb: 33 men per mile of line per 12-hour shift for average resistance to control.
50	592	351	*249*	216	128	76	41	26	16	
100	1,183	701	*498*	431	256	152	83	53	31	
200	2,367	1,403	*997*	862	513	303	165	106	63	
300	3,550	2,104	*1,495*	1,293	769	455	247	159	94	
400	4,734	2,805	*1,993*	1,724	1,026	606	329	212	126	
500	5,917	3,506	*2,491*	2,155	1,282	758	412	265	157	
600	7,101	4,208	*2,990*	2,586	1,538	909	494	317	189	
700	8,284	4,909	*3,488*	3,017	1,795	1,061	576	370	220	
800	9,467	5,610	*3,986*	3,448	2,051	1,212	658	423	251	
900	10,651	6,311	*4,484*	3,879	2,308	1,364	741	476	283	
1,000	11,834	7,013	*4,983*	4,310	2,564	1,515	823	529	314	

NOTE.—This table can be extended without serious error.

Additional Airplane Accident Data.—In Mr. Headley's article, "Wings and Parachutes Over the National Forest" in the October 1940 Fire Control Notes, a request was made for corrections or additions.

The following have been received from region 5:

"July 10, 1920. Sergeant Wayman Haynie and Corporal Salicido were killed in an airplane crash in the vicinity of Alturas, Calif. Forest Service Observer Harold Robie also lost his life in this crash. [This is probably the 1921 accident mentioned by Headley.—Ed.]

"September 7, 1921, Sergeant T. J. Whissel and Cadet Robert Koelp, both of the Army, met death in the crash of a DH–4 Army type airplane while taking off the Montague Airport east of Yreka, Calif."

Forest Supervisor Myrick of the St. Joe National Forest submitted a corrected account of the accident Headley referred to as that of Howard Flint and Pilot Nick Mamer. The pilot was Jack Rose who was employed by Nick Mamer who had the Forest Service contract for 1928. The story of this accident is reported in Crocker's article in this issue of the Notes.

GUIDES TO THE JUDGMENT IN ESTIMATING THE SIZE OF A FIRE-SUPPRESSION JOB

A. A. Brown

Fire Control—Region 2

Basic to determinations of the manpower needed to control a fire is an estimate of perimeter of line which must be worked. The author develops a rule of thumb for determining perimeter from the length of the fire. The problem of estimating areas from the length of fires is approached from a different angle than the area determinations in Mr. Hanson's article in this same issue. The articles overlap only slightly. The two studied together may lead to further developments.

Fires vary so much in conditions, cover, and behavior that the generalizations which may be drawn for *all* fires can be summed up on the fingers of one hand. The more experienced the fire fighter, the more he avoids committing himself or his plan of control to any fixed or precise rules of fire behavior. Nevertheless, every valid generalization that can be made and every rule that does not have too many exceptions to be useful contribute to making a science of forest-fire control.

In the course of a preliminary study of the patterns of burns in southern California chaparral, conducted by the writer in 1935, it became apparent that within limits such fires tend to follow certain rules in their relative dimensions and shapes and, consequently, in their areas and perimeters. Such relations, particularly that of the long axis of a fire to its area and perimeter, were further tested in 1938 and 1939 using burned areas in the Central Rocky Mountain Region in lodgepole pine, ponderosa pine, and other characteristic types. The tests were based on all of the larger fires for which dependable maps existed. The resulting relationships were summarized by a rule of thumb and by a graph, which were included in the appendix of the Region 2 Fire Control Handbook in 1939. These have proved so useful as guides in preliminary estimates of acreage and perimeter of going fires that they are repeated here for possible reference value to other regions.

Estimating Perimeter From Area

The usual starting point is that of estimating area, then of converting to probable perimeter. Mr. L. G. Hornby developed a relationship for determining perimeter for region 1 fires which is being widely applied in other regions. According to this relationship, the perimeter of a fire is likely to be one and one-half times the perimeter of a circle of equivalent area. This gives a very conservative estimate in terms on fire line to be built if the fire is long and narrow or very irregular. However, the relationship of perimeters of burns to

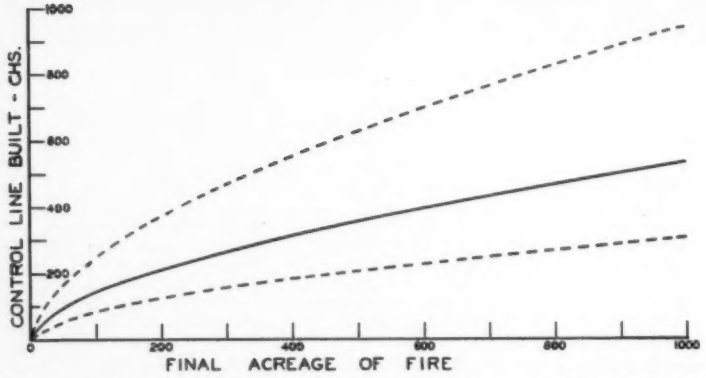


CHART 1.—Relationship between chains of control line actually built and final acreage of fire.

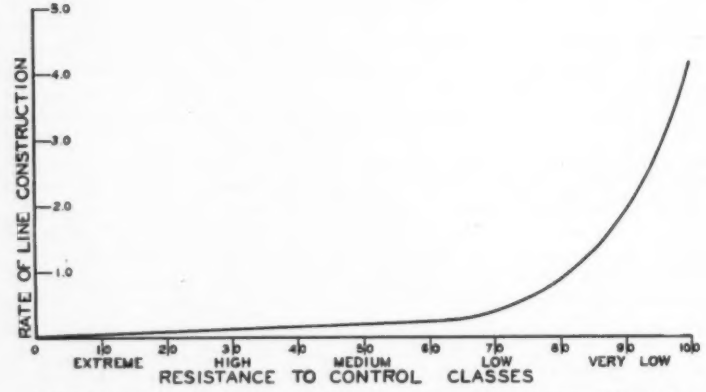


CHART 2.—Rates of line construction by classes of resistance to control.

the perimeter of a circle of equal area is a very useful one and can be applied whenever a good estimate of the area is available. For application in region 2, the relationship was found to be more nearly one and two-thirds the perimeter of a circle of equal area for fires under 20 acres in area, with a tendency of small, slow-burning fires to exceed even this ratio, but with a wide scatter of ratios.

A useful rule of thumb that can be applied as a check when the starting point of calculations is "estimated area" is that of converting the area mentally to a rectangle and adding up the sides. For example, an area of 3 acres can be visualized as a rectangle 5 chains by 6

chains in dimensions. If the sides are added up, the result is 22 chains, which is a fair approximation of the probable perimeter to be worked. One and one-half times the perimeter of a circle of this area gives 29.10 chains and one and two-thirds gives 32.3 chains. The dimensions assumed influence the result. If a rectangle 15 chains by 2 chains were assumed, the result would be 34 chains. Dimensions approaching those of the length and width of the actual fire will give the closest approximation.

The weakness of calculating the perimeter of a fire from its estimated area lies in the notorious inaccuracy of first estimates of the area. This is particularly true of large or fast-spreading fires which cannot be seen as a whole from some vantage point.

Estimating Perimeter From Length of Fire

Usually, the first information available is that of where the fire started and of how far the head of the fire has reached. If this is known, the total length of the fire can quickly be checked on any map and the long axis of the fire used instead of area in approximating the perimeter. A study of the burned-area maps of 65 fires from the regional record showed a very close correspondence between actual perimeter and the product of this long axis times $3\frac{1}{7}$ or π. In other words, the perimeter is likely to be equivalent to that of a circle having a diameter equal to the longest dimension of the fire, and fire producing a burned area 14 chains long in its direction of spread would have a perimeter of 44 chains. This appears to give the closest estimate of all for conditions in region 2 and has the further advantage of being well adapted to estimating the perimeter added by further spread. For example, if a fire has started to crown up a slope and cannot be checked until it reaches the top of the ridge which is 20 chains ahead, it is easy to extend the expected length by this amount in calculating the length of fire line that will be required. If the fire has assumed two heads which will be controlled separately, the axes of both should be added in calculating the perimeter. The perimeter of spot fires needs also to be added.

Estimating Area From Length

There is a fairly consistent relationship between the total length of a fire and its area, though there is potentially a greater margin of error in estimating area of small fires from length only than in estimating their perimeter from length. The accompanying graph shows this relationship for 65 class C fires from the region 2 record. The curve can be used as a guide to preliminary estimates of area for telegraphic reports as soon as the distance the fire has traveled is known. For example: If the fire is 50 chains long, an area of 70 acres is indicated. The curve will overestimate the area of very long narrow burns and underestimate the area of fires where the width and length are nearly equal. If a fire has two prongs, the best estimate will result from treating it as two fires. These estimates are all in terms of horizontal or map distance and need to be adjusted upward to cover the slope distances involved in chains of line. In country with an average of 30 percent slope this amounts to approximately 5 percent.

The McVey fire of 1939 in the Black Hills extended a distance of 11.3 miles, or 904 chains, and had a final area of 22,184 acres. By extending the attached curve or by dividing each of these values by 10, it is seen that it gives an area estimate corresponding to a long dimension of the burn of 904 chains, or over 21,000 acres, which is very close to the actual area. The total perimeter, which amounted to approximately 46 miles, would require a long axis of approximately 14.7 miles. This also is approximated if the two changes of direction of the fire are taken account of by breaking the axis into a three-direction line and the resulting perimeter is adjusted to average slope distances over which fire line will be constructed and measured on the ground.

Adjustments of Indicated Perimeter

On most large fires various barriers will be present which reduce the amount of fire line required. No estimate can be considered complete which does not take full account of reductions in the size of the job that will result from this source. At times, the job may be reduced 50 percent or more because of bare rock, green grass, or water surfaces which adjoin parts of the perimeter.

Harder Shoes for the Hard Tails.—The granite slopes of the central Idaho area are exceedingly rough on horse and mule shoes. Our back country packers and rangers say a set of ordinary blacksmith or pressed shoes lasts only an average of 6 weeks. On forests having several pack strings the cost of keeping the animals shod represents a considerable outlay.

One of the Challis guards conceived the idea of facing the shoe heel and toe calks with stellite (hard surfacing material used on bulldozer cutting edges, ripper teeth, etc.) for longer wear. He reports using the same shoes for an entire season, resetting them as often as necessitated by the hoof growth.

The same idea was tried out on our service strings this past season and found highly effective, cutting our costs for shoes by at least 50 percent. The cost of facing the calks is low, only about 8 inches of ¼-inch rod being used per shoe.

The stellite can be applied either with an acetylene torch or arc welder in a few minutes per set of four. The technique is simple: place the shoes on a flat surface with the calks up and apply about ¼ inch of metal evenly over the wearing surface of the heel calks and run a bead of the same thickness on the toe calk.

Shoes thus treated will last at least twice as long as ordinary untreated ones. Our experience indicated, however, that the heating of the shoe in applying the stellite tends to loosen the toe calks of blacksmith shoes and that they are apt to come off unless the precaution is taken to spot weld the toe calk to the shoe at the time the stellite is applied. Spotting them in a few places with ordinary welding rod will overcome this.—M. G. MARKLE, *fire assistant, Challis National Forest.*

TRAINING AND PLACING COOPERATORS ON LIGHTNING FIRES

WILLIS W. WARD

District Ranger, Malheur National Forest

A definite plan is offered for combining "training" and "doing" in developing a corps of cooperators trained in fire-suppression techniques. The plan is simple, and its efficiency rests to a great extent upon the ability of the district ranger to train his regular forest guards and his willingness to delegate the bulk of the training job to the guards. This plan for mobilizing and using cooperators in this manner on lightning fires on a ranger district has a direct relationship to the national-forest problem as presented in the previous article in this same issue. The organization and training of cooperators available to meet any fire emergency is a problem to tax the ingenuity of all personnel involved.

Various systems are employed throughout the regions to combat numbers of lightning fires that start in a single storm. The systems vary according to available manpower, accessibility of country, methods of travel, and many other influencing factors. However, with the roads, trails, airplanes, radios, and what-nots men and supplies can now be placed almost anywhere.

Coupled with the need for fast, energetic, and effective action on groups of fires is the problem of training cooperators and short-term men. To accomplish this the following plan of training "on the job" is used on the Malheur:

When a report is received that a lightning storm is approaching, the dispatcher calls for previously contracted cooperator crews and transportation. The number, location, and size of standby crews used depend upon the direction and intensity of the storm. The men are dispatched with food, tools, and bedding and placed on communication, either radio or telephone, and preferably immediately in the storm path. The men are then divided into crews of from two to four men. Each crew has its own food for 2 days, tools, etc.

The dispatcher designates one man in each crew to be in charge. The crew leader (for the purpose of training) is usually a guard or a cooperator who has had fire-chasing and fire-fighting experience. In the event the leader is a guard, his regular position is immediately filled by a man who has had training for the emergency. Each district has from one to three such men.

The ranger and usually one experienced guard are available to go from one station or fire to another and give the training necessary in look-out work, fire chasing, and fire fighting. Where all of the crew is inexperienced, he can make the final inspection to make sure the fire is out without additional time and expense. The ranger also can train his dispatcher and can give assistance when needed. Of course, the ranger keeps in touch with the general situation on his district by frequent contact via short-wave radio or otherwise.

The dispatcher keeps a record of the chaser crews and as they become depleted he immediately sends in fresh crews and supplies.

The system described has proved very effective from all angles. Through this plan cooperators have been given training, and a few small fires have been prevented from becoming large. It is true that there is plenty of hiking for the ranger and whoever helps in the same capacity, but this physical strain is nothing compared to the mental strain caused by a board of review on an extra-period fire.

ENLARGED PHOTOGRAPHS IN FIRE TRAINING

J. K. Blair

Wenatchee National Forest

The training of overhead and dispatchers for fire-suppression duties confronts most forest-land managers. Among the visual aids used in training are motion pictures, slides—especially if colored, sketches, relief maps, and enlarged photographs. The practical suggestions which are given concerning the use of enlarged photographs will point toward possible variations which will afford training to other types of personnel such as radio communication men. A series of such photographs taken during the progress of a fire offers much to a supervisor in meeting his training problem. If progressive pictures are not available, progress might be indicated by marking several prints of one picture.

Setting up for the trainee situations comparable to an actual large fire or a number of lightning fires is a problem that confronts forest officers conducting fire-suppression training for fire overhead and dispatchers. The use of enlarged panoramic pictures offers one approach.

Photograph enlargements may be of any size desired by the training officer and may cover as large an area as needed for the problem to be presented. A 6- by 10-inch picture enlarged to 24 by 40 inches has been found a workable size for most problems.

In setting up a problem for overhead, the training officer prepares his photographs in advance. With white signmaker's ink he sketches the boundaries of the fire, shows the area in acres and the perimeter in miles or chains, indicates direction of spread, spot fires, roads, trails, camp sites, distances, fuel and timber types, and any other information necessary to give a complete picture of conditions. On a supplemental sheet he gives weather conditions, manpower and equipment available, time of day, and additional information not shown on the picture. Each trainee is required to work out from the information presented his plan of action to control the fire. After each trainee has worked out his solution, he presents it to the group. Following each presentation the group discusses the pros and cons of action taken, summarizing with the determination of the proper action. Numerous other individual problems may be set up, such as backfiring, line location patrol, mop-up, communication, service and supply, and calculation of probabilities.

The use of photographs in training dispatchers has many possibilities also. On the picture the training officer may show a number of fires starting from a lightning storm; these may vary in size from class A to C, or larger if desired. Here again the location of roads, trails, guard stations, cooperators, forest crews, and CCC camps is

shown, and on a supplemental sheet all other factors pertaining to the particular problem are given. The procedure of each trainee working out his own solution and presenting it to the group is the same as for the overhead problems. If deemed advisable by the officer conducting the training, immediately following the working of the first problem he may present to the group another problem on a different set of pictures. Frequently this is done to impress upon the trainees the fact that another lightning storm may follow, and to show the necessity for being in a position to handle the fires from storm No. 2 along with No. 1.

Since all fire training cannot possibly be done on actual fires and during the time of peak lightning loads, the use of enlarged photographs is just one of many ways to make the training program represent, as nearly as possible, actual conditions.

Data on Plane, Truck, and Packstring Transportation.—Planes, trucks and packstock were used to transport supplies to the Deer Creek Fire on the Idaho National Forest in 1940. Some interesting data on these different methods of transportation follow:

The 200 men employed in suppressing this fire used 34,230 pounds of supplies: 10,150 pounds were dropped from planes with condemned army chutes, 160 pounds to the chute and 850 pounds per plane load.

Trucks and packstrings transported 24,080 pounds of supplies to this fire. Trucks hauled the supplies 117 miles, pick-ups 12 miles, and pack strings 10 miles.

The truck haul was accomplished in 6 hours with a full load.

The 12-mile pick-up haul was over very difficult roads. With 800 pounds per load a round trip was accomplished in 3 hours.

A round trip of 20 miles was made with a 10-mule packstring, each mule carrying 185 pounds.

Problems of transportation on this fire are representative of those encountered in the Idaho Wilderness area, and it is thought that the following costs apply to approximately 800,000 acres:

Plane transportation, per pound	$0.063
Truck and packstring, per pound	.069

—F. E. Powers, *Idaho National Forest.*

On this fire airplane transportation was used for 30 percent of the weight of the needed supplies. Although costs were about the same by each method, the difference in transportation time was great. More studies like this one are needed to advance the field of knowledge of conditions which make desirable the use of airplane transportation. What measures should be used for determining the best method of transportation for any particular type of articles, considering different conditions and the urgency of their arrival? How can airplane and other transportation facilities be used in harmony with each other on the same fire in order to best accomplish the transportation job?—Ed.

FOREST-FIRE DANGER WARNING POSTERS

NATIONAL PARK SERVICE

Efforts in the field of fire prevention take many forms. Posters or signs showing the existing class of fire danger for the day constitute one visual aid. The poster illustrated and described was developed by the National Park Service, Region 1, Richmond, Va, to arouse an intelligent interest in fire prevention. The letter and illustration were submitted by Fred H. Arnold, Regional Forester of the National Park Service.

August 26, 1940.
Regional Office Letter No. 566.

NATIONAL PARK SUPERINTENDENTS,
NATIONAL MONUMENT CUSTODIANS,
RD AREA MANAGERS,
INSPECTORS,
FORESTERS

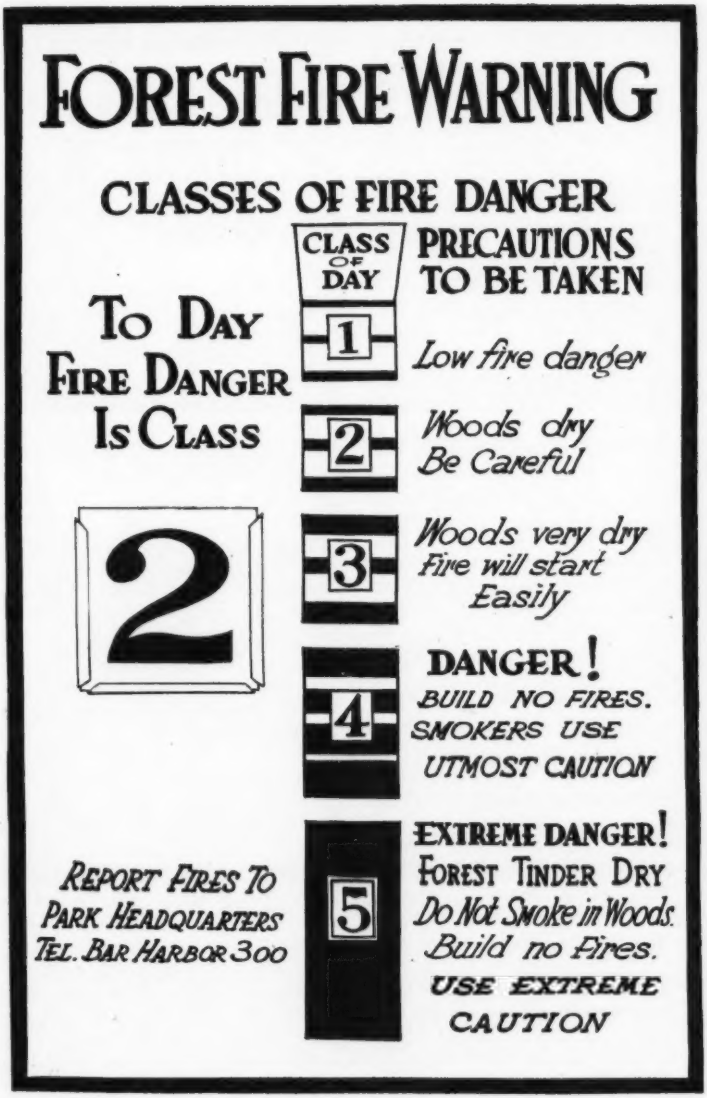
Forest-Fire Danger Warning Posters

The fall fire season is near at hand, and in making due preparations for it all elements of the fire-protection system in each area should be examined and put in first class working order. This applies with equal emphasis to training, organization, equipment, detection, communication, transportation, and fire prevention. With reference to the latter activity we believe you will be interested in the ingenious poster device made at Acadia National Park which is illustrated and described on the attached sheet. On the basis of the demonstrated effectiveness of this means of inducing cooperation in fire prevention at Acadia it is thought that boards similar in principle, if not in design, could be used to equally good advantage in other areas.

Workers in the park as well as visitors are fascinated by this board; it arouses their curiosity, and their native inquisitiveness about something new leads them to explore its meaning. These reactions have been observed where the board has been displayed at Acadia and the interest thus aroused has resulted in employees' and visitors' increased realization of the need for exercising greater care with fire in the woods.

The Acadia board is not intended to be regarded as an adopted standard design but the information concerning it is issued to acquaint others with the idea and how it has been put into practice in one area. If such device might be helpful in your area, you should feel free to use local talent and ingenuity in adapting or improving the principle of the Acadia board to make it more effective with respect to your particular fire-prevention problems.

FRED T. JOHNSTON,
Acting Regional Director.



Forest-fire danger warning posters.

HIGHWAY FIRE-PREVENTION SIGNS

EARL TENANT

Fire Control, Region 1

The use and effectiveness of fire-prevention signs is being currently studied by the U. S. Forest Service. One approach toward increased fire consciousness used by region 1 is the adaptation of the principle of serial signs to the subject of fire prevention.

Late in the fall of 1937 a study made of man-caused fires occurring along the main highways in the northern Rocky Mountain region, brought out the need for a suitable prevention sign. All available signs were studied, but none seemed to be suitable. The need was for something that would tell an interesting story in a very few words and be readable from a car traveling 50 to 60 miles per hour.

Ranger Stanley Lukens was given the job of designing a suitable sign. After several experiments a set of signs was developed following the principle of the Burma-Shave advertising plan but using a combination of illustrations and word messages instead of words alone.

The signs are designed to hang on gibbets at 500- or 600-foot intervals. They can be put on either side of the road and are placed in sets of four. The story is told in sequence. No. 1 reads, "Careless Smokers Start Fires;" No. 2, "Don't Be a Flipper;" No. 3, "Use Your Ashtray;" and No. 4, "Thank You." The picture painted on each sign illustrates the words. The signs are painted on both sides and from either direction the story reads the same.

The boards are 3 by 4 feet of ⅜-inch plywood. They are treated with three coats of paint before letters and designs are painted. Only pure colors in oil are used. The outline of the letters and figures is placed on the boards by the use of burnt sienna powder dusted along the perforated lines of the original paper copy. They are then painted freehand. After the paint is dry the boards are given three spray coats of clean, waterproof lacquer.

The frame is made of stained peeled poles which are bolted together diagonally at the corners. A groove is rabbetted out in the frame for the sign. The edges of the plywood are treated with white lead before being placed in the grooves.

The cost of constructing the first signs was high, being approximately $21 per sign exclusive of the frame and post. The costs were excessive because of the hiring of a skilled artist and the slow process of hand painting. After the experimental stage, it was decided to turn the job over to the CCC sign shop. The boys turned out excellent work (not quite as good as the artist, but very satisfactory) at a cost of $2 to $3 per sign, not including the CCC labor.

The reaction of the public has been surprisingly good, and has encouraged the region to the extent that 10 sets of these signs have been placed on main highways. Favorable comments have come from

Highway fire-prevention signs.

advertising men, editors of papers, numerous tourists, etc. The Chamber of Commerce at Felton, Calif., has set up a project to place these signs along the highway through the San Lorenzo Valley. A perforated copy of the letters and designs was furnished to them by this region. It is understood that this work is being done through the cooperation of the State forest ranger.

"EVERYTHING ELSE OUT ON FIRE"

Region 1, U. S. Forest Service

Region 1 has always been proud of its parade entries, particularly the packstrings and mules transported by truck. The lone and almost worn-out truck presented in the parade at the opening of Western Montana State Fair on August 22, 1940, was therefore especially significant. The ingenious dramatization of the existing situation is reported to have caused as much or more favorable comment than the usual ambitious entries.

Everything else out on fire; this picture almost speaks for itself.

Mr. Axel Lindh, in relating the circumstances which led to this exhibit, gave the following facts:

During the preceding 5 days the region had nearly 300 lightning fires from an almost continuous lightning storm. On August 21 there were 32 class C or larger fires going, of which 11 were class E. In the south, a fire in Yellowstone National Park resulted in the loan of 42 forest officers for a couple of weeks and the shipment of equipment and supplies for about 1,500 men. Considerable equipment had also been sent to region 4. To the north, efforts were being made to stop an old fire from entering the Kootenai National Forest from Canada. One 800-acre fire was burning within 5 miles of Missoula. Within the region all Government pack mules were at work with some 25 rented packs also on the job.

A METHOD FOR APPRAISING FOREST-FIRE DAMAGE IN SOUTHERN APPALACHIAN MOUNTAIN TYPES[1]

GEORGE M. JEMISON, *Forester*,
and
JOHN J. KEETCH, *Junior Forester*,
Appalachian Forest Experiment Station, Asheville, N. C.

Introduction

More than one million dollars is paid every year for forest-fire protection in the southern Appalachian Mountains.[2] This expenditure is made by Federal, State, and private agencies as insurance against the inestimable damage to human life and property, timber, water, and other values if the 11,000 fires each year were not controlled and if unrestricted setting of fires were not prevented. There is no way to place a realistic dollar value on the damage that would occur if there were no attempts to control the start and spread of fire. The most profitable expenditure for protection cannot be definitely determined until damage reduction from increased expenditures can be evaluated.

If the damage caused by fires under the present degree of protection amounts to several million dollars a year, it may be better business to increase expenditures. Perhaps the amount of fire damage in a region could be reduced two million dollars by spending an additional half million dollars on protection. If additional funds are not available, from the standpoint of potential damage perhaps more money should be allotted to some sections, less to others. The questions arise, How much should be spent on this protection, and in which areas to best advantage? Present-day fire protectionists cannot know the answers to these questions until it is possible to make accurate damage appraisals.

Although some type of damage appraisal is almost universally practiced by fire-control agencies, the lack of uniformity in the methods used, the difference in the underlying concepts concerning the nature of damage, and the values involved in the different schemes have blocked every attempt to determine logically how fire funds might be used more effectively. One method now in use requires that damage be considered only when merchantable timber is killed; another claims that most of the damage is to young growth, and that losses in merchantable stands are negligible. Because there is a dif-

[1] Assistance in the preparation of these materials was furnished by the personnel of the Works Project Administration, Official Project No. 765–32–3–3.

[2] Based on partial information from incomplete reports over a 5-year period from 1933–37, inclusive, U. S. Department of Agriculture, Forest Service, Washington, D. C.

ference of opinion, each fire-control agency uses a different method of appraisal and there is no standard of comparison.

There is, therefore, definite need for a damage-appraisal system based not on opinion, but on a study of the true nature of forest-fire damage. To determine what this system should be, studies of fire damage to the major forest types in the Appalachians have been made. A system of appraisal has been worked out as a result of these studies which provides a standardized method for evaluating damage from three sources: First, that from mortality; second, that caused by cull (decay) following butt wounding; and third, that associated with slower growth rates of wounded trees of some species. The system described here is confined to losses in tangible timber values of trees of commercial species, including merchantable trees, and those below merchantable size which can reasonably be expected to become a part of the future crop. Extremely important are damages to intangible forest assets, such as aesthetic, recreational, and watershed values, and loss in income of industries and workers dependent on forest products, but these losses are not included in the proposed system as no means have yet been established for their determination.

Basis of Fire-Damage Appraisal System

The data for this proposed system of damage appraisal were derived from 150 random quarter-acre plot tallies on 41 recent burns in the mountains of North Carolina, Virginia, West Virginia, Kentucky, and Tennessee, and from 4 large permanent sample plots in North Carolina and Georgia.

From the records taken on these plots, the total volume of trees of sawtimber size, dead and dying because of the fire, was assigned a value based on the stumpage prices in table 1. These prices were chosen as fairly reliable averages over a long period.

TABLE 1.—*Average stumpage values*

Species	Value per M board feet
Yellow poplar and black cherry	$9
Northern red, white, and post oaks; basswood; ash; sugar maple; and black locust	8
White pine and shortleaf pine	5
Black and chestnut oaks; red maple; and redgum	3
Pitch and Virginia pines; blackgum; beech; hickory; hemlock; buckeye; southern red and scarlet oaks	2

The damage resulting from the fire-killing of trees below sawtimber size was measured in terms of the loss suffered by the timber owner by having to wait for his return for a period longer than would have been necessary in the absence of fire. This delay to future returns is the difference between two discounted values, one determined from future yields [3] with no fire, and the other from future yields following fire under the assumption that killed trees are replaced by others of the same species. In computing the future value of dead and dying tree (from stumpage prices given in table 1), a

[3] Forecasts of the time to reach sawtimber size were based on growth curves for many species presented in the following reference: Barrett, L. I., Growth rate of northern white pine in the southern Appalachians. Jour. For. 31: 570–572, May 1933.

value was placed only on those trees that would obviously have a place in the final crop. Thus, many fire-killed trees that might have died because of future suppression were eliminated from the appraisal.

The present worth of future yields was determined by discounting future values at 3 percent interest, compounded annually.

The damage to trees with basal fire wounds, was the discounted value of the cull volume (caused by decay) present when the wounded trees become merchantable.[4]

Damage caused by the reduction in rate of diameter growth was based on the reduction in merchantable volume per acre of stands containing fire-wounded scarlet oak and the discounted value of the loss in volume. Scarlet oak was the only species studied which showed a reduction in gross volume increment of individual trees as a result of basal wounding. Therefore, losses from this source are influenced only by the average representation of wounded scarlet oak in the various types and condition classes.

The total damages resulting from these kinds of loss were segregated into classes representing several degrees of fire intensity, condition class, type, and degree of stocking. All of these factors were found to have an important bearing on total damage.

With this classification as a framework, table 2 was completed.

Application of the Damage-Appraisal Table

The table can be applied on the basis of the appraiser's best judgment or with careful surveys of the burned area, depending upon the time and money available for the appraisal. Obviously, the most accurate appraisal will result from actual field surveys. The facts about a fire essential to the use of table 2 consist of the items discussed separately in the following paragraphs:

The first step in appraising fire damage is to determine the *acreage burned.* This area should then be classified in four ways.

1. *Danger class.*—Taken from the danger station nearest the fire for the day and hour when the fire made its greatest run. If danger ratings are not available, the fire severity will have to be estimated according to whether it is of low, medium, high, or extreme severity, corresponding to classes 2 to 5 in table 2.

2. *Timber type.*—Hardwood, pine-hardwood, pine. In the hardwood type, hardwood species constitute at least 75 percent of the dominant and codominant stems of trees of commercial species; pine species in the pine type are in the same proportion. In the pine-hardwood type, coniferous species constitute from 26 to 74 percent of the dominant and codominant stems of trees of commercial species.

3. *Condition class.*—Sawlog or under-sawlog. A volume of at least 600 board feet per acre in trees of saw timber size must be present before the stand can be considered as sawlog condition class. The minimum saw timber size for pines was set at 9 inches d. b. h.; for yellow poplar, basswood, cherry, and ash, at 11 inches d. b. h.; and for all other species at 13 inches d. b. h. Any stands wherein the volume per acre of saw timber trees does not equal 600 board feet

[4] Hepting, George H., Division of Forest Pathology, Bureau of Plant Industry, The prediction of cull following fire in Appalachian oaks. Submitted to Jour. Agr. Res.

TABLE 2.—*Average damage per acre in dollars*

HARDWOOD TYPES

Fire danger severity	Class 2 (low)		Class 3 (medium)		Class 4 (high)		Class 5 (extreme)	
Condition class	Sawlog	Under-sawlog	Sawlog	Under-sawlog	Sawlog	Under-sawlog	Sawlog	Under-sawlog
Stocking:								
Good	0.30	0.55	0.84	1.40	2.20	3.38	5.02	7.27
Medium	.34	.45	.92	1.16	2.36	2.81	5.27	6.06
Poor	.40	.41	1.01	1.05	2.49	2.54	5.46	5.51
PINE-HARDWOOD TYPES								
Stocking:								
Good	0.37	0.61	0.99	1.49	2.44	3.34	5.24	6.78
Medium	.42	.54	1.10	1.34	2.62	3.01	5.53	6.13
Poor	.49	.50	1.21	1.25	2.79	2.85	5.76	5.82
PINE TYPES								
Stocking:								
Good	0.24	0.35	0.68	0.90	1.81	2.19	4.22	4.83
Medium	.28	.34	.75	.88	1.95	2.16	4.47	4.78
Poor	.32	.33	.84	.86	2.09	2.13	4.68	4.73

should be classed as under-sawlog condition class, except those areas which do not contain at least 80 well formed healthy seedlings of commercial tree species on an acre, dominant in relation to undergrowth, and well distributed. Areas that do not contain this minimum number of seedlings should be considered nonforest.

4. *Degree of stocking.*—Good, medium, poor. The degree can be determined by judgment or by using accompanying table 3 as a guide. The method of determining degree of stocking will depend upon the time and money available for field examination. The limits for each degree of stocking by condition class and type are defined in table 3, which gives net volumes in board feet per acre for sawlog condition class and net volumes in cubic feet per acre for under-sawlog condition class. The volumes should be based on trees of commercial species present in the burned area.

In actual practice it may be difficult to fit every fire, especially one larger than 10 acres, into only one of the 72 possibilities in table 2. For example, a proper classification of the acreage on a 100-acre fire might indicate that while most of the area burned with class 4 severity, some of it burned at night, or in a hollow, with a corresponding drop in fire intensity to class 2 or 3. More than one type might be represented, perhaps all three, and the same applies to condition class and degree of stocking. In such cases, weighted averages of the amounts read from table 2 would result in the most accurate evaluation of damage. An experienced man, well acquainted with his district, could probably classify the timber on the burned area by observation and estimate. The less experienced man might have to support his judgment with data from field surveys.

Possibly the most common use of table 2 is illustrated by the following example: Assume a 50-acre fire of medium intensity burned through a stand in which it was estimated that 60 percent of the dominant and codominant trees were pine and 40 percent oak.

TABLE 3.—*Degree of stocking* [1]

Type	Sawlog condition class (net volume in board feet per acre in trees of sawlog size)			Under-sawlog condition class (net volume in cubic feet per acre—trees 5 inches d. b. h. and larger		
	Poor	Medium	Good	Poor	Medium	Good
Hardwood	0–1,000	1,000–2,900	2,900+	0–80	80–430	430+
Pine-Hardwood	0–1,300	1,300–3,700	3,700+	0–90	90–510	510+
Pine	0–1,800	1,800–4,600	4,600+	0	0–660	660+

[1] From Forest Survey data, North Carolina Unit No. 4.

The stand contained an estimated average volume of 1,250 board feet per acre in trees of sawlog size. Therefore, the stand should be rated as *sawlog* condition class. Since neither pine nor oak made up three-quarters of the dominant and codominant trees, the type is *pine-hardwood*. In table 3, opposite the pine-hardwood type for sawlog condition class, 1,250 board feet fall under *poor* stocking. In table 2, for medium severity (class 3), sawlog condition class, pine-hardwood type, and poor degree of stocking, is the damage value of $1.21 per acre. This value multiplied by 50 acres equals $60.50, a total damage to timber stand.

Night Azimuth Readings.—Various methods have been used by forest lookouts to obtain satisfactory azimuth readings at night. Most of these involve some means of illuminating the vertical cross hair of the alidade without at the same time obliterating the light from the fire.

Knute Turnquist, lookout on the Oakridge Ranger District, has a solution which is both simple and accurate. A piece of heavy paper is fastened to the front sight, broadside and to the right of his line of sight with the edge exactly on the vertical cross hair. No light is used; the lookout sights through the rear peep slot and revolves the fire finder until the blaze is barely visible from behind the edge of the paper. He then turns on the light and reads the azimuth.

Instead of a piece of paper, a rectangular metal plate, the length of the vertical hair, could be used with one edge at the line of the vertical hair. It could be designed to revolve out of the way during daylight hours.

The device described would be somewhat similar to the small metal plate found on the newer fire finders, which enables the taking of a minus vertical angle at night.—[Adapted from article by R. M. BEEMAN, *Williamette National Forest*, in October 1940, Six-Twenty-Six.]

AN EFFECTIVE METHOD OF CLEANING KAPOKS

J. W. Farrell and Don Park

Idaho National Forest

The use of sleeping bags for fire-fighting personnel has grown rapidly within the past few years. Attendant upon their use is the problem of cleaning the bags. Although the method presented in this article does not reduce this task to simple terms, as in laundering the woolen blankets formerly universally used by fire fighters, it does offer a method highly satisfactory under conditions existing on the Idaho National Forest.

The Idaho National Forest, as well as others in region 4, has been confronted over the past several years with the problem of properly cleaning and renovating kapok sleeping bags. After giving other methods a fair trial and not being able to get a satisfactory job done by commercial cleaning establishments, the Idaho National Forest personnel developed a procedure that has proved very satisfactory. During the past fall 2,700 beds were cleaned at an average cost of 90 cents per bed. The cleaning job furnished employment to 8 fire guards for a period of 2 months beyond the regular guard assignment.

The Idaho plant has been gradually developed over a period of 3 years. It includes the following equipment:

1. A home-made washing machine consisting of an open tank of 200-gallon capacity using compressed air in lieu of a mechanical agitator.

2. A double, overhead track which runs from the storage building to the drying yard. Frames 6 by 8 feet in size are suspended from the track by roller carriers, and each frame is fitted with enough sliding hooks to hold 20 pads. (If a smaller or more temporary set-up is desired, lines can be used in place of tracks.)

3. A single hammer compressor with ordinary garden hose for the blowing operation and ¼-inch hose for the cleaning operation.

4. An ordinary garden hose nozzle to be used in blowing the beds and spray guns for applying cleaning fluid. (We were unable to find guns on the market with sufficient force to carry the proper amount of cleaning mixture well into the kapok filler, so we made our own, using ⅛-inch black pipe and ⅛-inch zerk fittings for jets.)

5. A supply drum for cleaning fluid. This is elevated about 10 feet from the ground.

Several worth while improvements could be made in the present plant. For example, a large industrial-type washer with a mechanical agitator might be an economical investment where the cleaning job is large enough to warrant it. Other types of equipment may be available which could be used just as effectively as those listed.

The statement which follows may help to clarify the procedure for other organizations that may be interested in developing a similar plant:

The beds are first dismantled by cutting the strings which combine the three parts; namely, the covers, sheeting bags, and the kapok bags.

The sheeting bags and covers are put aside to be washed in the contrived washing machine, using ordinary soap and water. The kapok pads are hung on the frame and drawn to the blowing station. Using the garden hose and nozzle the entire pad is blown thoroughly with air under 100 pounds pressure. This operation removes all loose dirt and dust and breaks up the lumpy mats in the kapok. The kapok becomes very fluffy and alive, thus prolonging its usefulness.

The frame with its load of pads is then drawn to the cleaning station. The cleaning fluid is highly inflammable so the station must always be located in the open and away from buildings. Common Stoddard solvent is used as the cleaning agent. The compressed air and solvent are supplied to the spray gun through separate ¼-inch hoses. No pressure is applied to the fluid in the supply drum, as the drum is elevated, but air pressure to the gun should be about 100 pounds. The fluid is applied liberally, about 1 gallon being used to each pad. During the spraying all grease spots and stains are rubbed with a stiff brush. As yet, no grease or dirt has been encountered that could not be removed by this spraying and brushing process. All adult vermin, larvae, and eggs are killed or destroyed.

After the cleaning operation, the pads are drawn on the frames to the drying section. About 3 hours under a warm sun are required for the pads to dry thoroughly. During cold weather, as much as 6 hours will be required. Regardless of the temperature, sunshine is important in the drying process. As soon as the pads are dry they are ready for reassembling.

The sheeting bags and covers are washed in the (washing) machine with ordinary soap and water. They are then hung on the frames and drawn into the yard to dry.

All necessary repairs are made to covers and pads before reassembling. Straps and fasteners are replaced, and torn and damaged parts are repaired by sewing in good pieces salvaged from beds damaged beyond repair.

When the beds are reassembled, No. 2 hog rings are substituted for the strings which normally hold a bed together. These are more easily and more rapidly applied, and are much more durable than the strings.

Size of the crew is important from the standpoint of economy. Drying conditions will govern the number of men used to a large extent. Generally two are used on the dismantling and washing, one on the dry blowing of the pads, two on the spray guns, and one track tender and one repairman. Necessary labor adjustments can be made on the dismantling and reassembling jobs.

The cleaning process was entirely new to all of the men this year, and we believe the cost per bed can be reduced by practice and experience.

Additional information on the process can be obtained from the Idaho National Forest.

SCOUTING FOR FIRE WITH AIRPLANES ON THE SAN JUAN

C. R. Towne

Assistant Forest Supervisor, San Juan National Forest

The "flivver" and other types of privately owned planes are becoming increasingly numerous in region 2 and are proving their value for emergency fire detection, particularly on forests where existing facilities are limited. Aerial detection may well justify a more prominent place in fire-control plans on such forests than in territory where intensive systems of fixed lookouts can be justified and maintained. Although the following article appeared in the region 2 bulletin, it was believed of sufficient importance to warrant broader dissemination.

During the hazardous periods in 1939 and 1940, some scouting by airplane was done on the San Juan National Forest. In 1939 no fires on the forest were spotted by the patrol. The training given the pilot, however, resulted in his picking up one fire on the Montezuma and two fires on the Pike.

In 1940 real results were obtained. On August 11, while traveling from Canon City to Durango, I sighted a lightning fire on the Piedra District in a heavy stand of white fir, some 10 miles from the nearest road or inhabitation. The fire had apparently started since earlier in the day when I had traveled the same course and had seen no sign of it. It was handled the following morning with two laborers, after it had reached a size of 0.25 of 1 acre.

On the following day, while scouting with a plane, a fire was picked up on the pine district in a ponderosa pine-oakbrush type in a blind area. This fire was sighted at 5:30 p. m., reported to Ranger Irwin at 6 p. m., and laborers were on the fire at 8:30 p. m. The fire had reached an area of 2 acres when laborers arrived and was held to that acreage when controlled.

Both of the fires described, if they had been allowed to burn until seen by cooperators, would, no doubt, have developed into large fires. As it was, they were held to class A and class B fires and extinguished with small costs.

On another occasion a fire was sighted some 10 miles northeast of Durango, where it would have been necessary in order to reach the fire to travel some 6 miles by truck and approximately 4 miles with pack outfit. Ranger Price figured that the fire was in the near vicinity of a stock association rider's camp, but, as it was Sunday, he was doubtful if the rider would be at the camp. Before starting a crew it was thought best to investigate the fire by taking a plane and scouting it. Accordingly, I took a plane and in 20 minutes was back with the information that there were men on the fire and they had it under control. The use of the plane cost $5. If a plane had not been used, it would have been necessary to send a crew into the fire, which would have cost much more than the use of the plane. The crew would, be-

cause of the roughness of the country, necessarily have had to remain overnight and return the next morning. In addition, the ranger would have lost at least 1 day's time and been away from telephone communication during a very hazardous fire period.

The San Juan is sold on fire patrol by airplane. Contracts were made this past summer with Norman Kramer, a local pilot, to do the flying. The contract called for $10 per hour for a small 65-hp., two-place plane and $12 per hour on a 145-hp., three-place plane. The two-place plane develops a cruising speed of approximately 90 miles per hour and can be throttled down to around 60 m. p. h. with safety, while the three-place plane develops a cruising speed of approximately 120 m. p. h., but can only be throttled down to a speed of around 100 miles per hour. Both planes have their place in scouting for fires. The three-place plane, which is much faster than the two-place plane, is the cheapest for long scouting trips but is not satisfactory or safe where it is necessary to drop down to low altitudes for checking fires. The two-place plane, although of less horsepower, is lighter and slower and can be dropped to as low an elevation as is necessary and be throttled down to a speed slow enough that ground conditions can be easily checked with the naked eye.

Simple Pick-up Barrel and Pump Outfit.—The best apparatus we have found for quickly extinguishing small fires on the "desert fringe," buffer strips, and No Man's Land is a simple pick-up barrel and pump outfit.

Most of the equipment needed for this outfit is available on any national forest or ranger district—a pick-up truck for transportation, four 50-gallon drums, an Edwards Midget pumper, and from 500 to 1,000 feet of ¾-inch garden hose.

One pick-up can handle two of the drums filled with water and the balance of the outfit. If needed, another pick-up, or truck, can keep the pumper pick-up supplied with water with the extra drums. We put a faucet in the bottom of the drums for filling back-pack cans.

This simple little outfit is useful for putting out small fires, without dramatics and with no heavy equipment tied up. It is better for the purpose than the heavier power take-off, high-pressure tankers, or chemical-pressure outfit.—W. E. ANDERSON, *Chelan National Forest.*

Comment on "The Stathem Fire Finder Disc" Article.—Readers who have for years used the tangent offset method for plotting the location of fires are somewhat confused in reading Mr. Strathem's article in the July 1940 issue of Fire Control Notes (p. 149), to note that the tangent offset for 1 mile is given as 69 feet rather than the approximately 92 feet per mile which is correct.

The error apparently arises in the first column of the profile table on page 155 where instead of vertical angles of 1°, 1½°, and 2°, the correct figures of ½°, 1°, and 1½° should be substituted to correspond with the differences in elevation given.

Likewise, in the examples on pages 149 and 150, the angle given as 2° should in each instance be listed as 1½° to make this angle correspond to the actual loss in elevation.—ROBERT E. REINHARDT, *junior forester, Region 6.*

BROKEN WINGS IN THE FORESTS

CLAYTON S. CROCKER

Fire Control, Region 1

Airplane use in forest-fire control is constantly progressing. As equipment is improved so also should our knowledge be extended as to what to expect of planes and their human masters, the pilots. As the so-called adventurous years pass it is well to have a record, such as this, of some of the trials of those who pioneered in the use of airplanes for forest-fire control. Finally, lest forest flying be considered merely a prosaic activity such as distributing salt on a cattle range, the men who are to function as fire bosses should personally accompany the pilot on some of his flights. The experience will reinforce the author's final caution "* * * don't ask the flying boys to do the impossible or the obviously dangerous thing * * *."

The article "Use of Aircraft in Forestry" (Forest Service mineograph, January 27, 1940) gives a condensed record of attainments in various phases of aerial transportation over the forests. The story of success is interesting and informational. However, it falls short as a complete picture of development in the field. The more gloomy chapters of the story need to be told, else in the future it should be forgotten that aerial forestry too had its pioneering hardships, its obstacles, and its hazards.

Knowledge of the facts may safeguard against repetition of error and serious mishap in years to come. It is also well to remember that this is the one and only phase of fire-control work which has been developed entirely at the risk of forest officers' lives. It has been a gamble, with life wagered against the odds of chance. The pay-off for each flight could be but one of two stakes—better fire control if we won; a widow with forfeited life-insurance policies, or perhaps life as a cripple, if we lost.

Many hundreds of changes have been taken. As a result we have great areas of green forest, which otherwise might have been burned. The one loss in this region is marked by the grave of our pilot, Bob Maricich. Why there are no more such graves, must be attributed in some measure to luck. Skill, brains, and intestinal fortitude have beyond doubt, been responsible for our good fortune. Even so, when a plane engine "conks out" over rugged forest terrain, a hundred miles from a landing fied, some element of luck must be present when the pilot and observer walk away from the wreckage.

A brief history of region 1 airplane accidents follows: It is not written for the purpose of discouraging airplane use. To the contrary, it is given as *an argument for better equipment*, more stability in employment of pilots, and a more careful consideration of the needs of this important arm of our fire transportation system:

1926. Ranger Jack Jost, observer, and Pilot Jack Rose.

They were scouting the Snow Creek fire in the Kaniksu country. In climbing high to clear the rugged Priest Lake Divide near the edge of the forest, the main oil line broke. Jost reports:

"We were on top of the Priest Lake Divide and due to dense smoke had zero visibility except straight down. The motor was stone-dead and it was several miles to the edge of the forest. We glided into Snow Creek Canyon and down it to its mouth in the farming country west of Bonners Ferry. We landed in one of those little hay fields, among wire fences and haystacks; barely missed a crew of men stacking hay; landed Okey, but the field was so small we had to plank over several irrigation ditches before taking off."

Jack's statement is typical. It gives the facts in only such detail as an old-timer believes necessary for the official record. He fails to record the hazards attending his ride in a dead plane, sliding and slipping between heavily timbered, cliff-strewn canyon walls; the nearness of spike-topped snags and treetops to the delicate fabric of the wings; the buffeting of up- and down-drafts; and a dead-stick landing among fence posts and haystacks.

Jack continues, "During July 1926 Jack Brien, observer, and Lieutenant Priestly, pilot, were forced down while on detection patrol in the heart of the Kaniksu Forest. They rode one of the old Army DeHaviland planes down with a bad motor. Neither was injured."

1927. Ranger Jack Jost, observer, and Pilot Nick Mamer.

Jost reports, "Mamer and I were forced down by engine trouble on the edge of Blue Lake, Kaniksu Forest. In taking off at start of trip, a cross wind let us drop about 150 feet and the shock damaged the motor. It cut out while were were over Blue Lake. We found a small meadow and landed satisfactorily. We had to clear dead snags from the end of the meadow before trying a take-off. Local farmers held the plane while Nick opened the motor wide, then they turned loose. We barely got out as the tops of snags ripped pieces of fabric from the wings. Close shave."

1928. Fire Chief Howard Flint, observer, and Pilot Jack Rose.

A new plane, the most modern of that time was purchased by contractor Nick Mamer for use in forest-patrol work. A short patrol from Spokane to cover the St. Joe Forest was made as a maiden flight for the new ship. Howard Flint, then in charge of fire control in region 1, and the region's most experienced observer, made the trip with Pilot Rose.

When well over the central part of the rough and heavily timbered St. Joe, the motor stopped. A fabricated timing gear, an innovation, had broken into pieces. No clearing of any kind was in sight. The area had been burned years before and the second-growth timber bristled with gray snags, a hundred feet tall.

Both men wore parachutes (which is seldom the case), but with one glance at the spearlike snags both decided to ride the ship down. A patch of trees, more free from snags than the remainder of the hillside was selected, and the glide was pointed in that direction. Upon nearing the treetops, a side wind slipped the plane into a tall snag and it hurtled down through the tree trunks and logs, a mass of wreckage.

Upon regaining consciousness, the men determined that their injuries consisted of one black eye and numerous bruises; they had a 12-mile hike cross country to the road. "Just another thing in development of our transportation," according to Howard's statement.

1930. *Assistant Supervisor Albert Cochrell, observer, and Lieutenant Bigelow, pilot.*

A patrol flight in the wake of a severe lightning storm took Observer Cochrell and Pilot Bigelow along the high, rough Pend Oreille Divide. They had just passed over North Baldy Lookout (elevation 6,185) when, without even a sputter, the motor stopped. Ahead and on both sides were steep, heavily timbered mountains. The open country of the Pend Oreille River was too far away to offer a landing chance. Behind, about a half mile, was a grassy opening on the ridge. It was steep, rough, and faced a timbered canyon bottom far below.

It was only a matter of seconds but the pilot took time out to answer a questioning glance from Cochrell, with a nod toward the selected spot and a smile of reassurance. He turned the plane sharply, dived in over the scattered alpine trees and pulled against the steep beargrass slope for a perfect landing. That it was steep is indicated by the distance the ship traveled after first touching the ground—45 feet.

Bigelow's first and only comment was, "What do you suppose happened to the old girl?"

By using wire from a nearby telephone line, the ship was anchored to the mountainside to prevent its rolling into the canyon. Investigation disclosed that the fabricated timing gear had failed. New parts were ordered by telephone from the nearby lookout. A pack train with equipment arrived the following day and repairs were made.

After considerable maneuvering, pushing, and pulling, the ship was moved to the top of the mountain. An opening through trees and outcropping rock ledges was selected. It was a short runway and so steep that a saddle horse could be ridden over it only by switching back and forth on contours.

When time arrived for the perilous take-off, Bigelow crawled into the cockpit and tested his motor. Upon glancing back he found he had a passenger. In answer to his look of surprise Cochrell merely replied, "Well, I rode in here with you, didn't I?"

When the motor had reached its top speed, the smokechaser from the lookout station severed the rope which until then had held the ship to the mountainside. With a roar the plane started down the hill, bouncing over beargrass hammocks and rocks; performing like a frightened rabbit, it headed straight down toward the timber. After what seemed ages to the passenger the nose took to the air and the tail jumped out of the beargrass, and they were once more in the air.

1931. Supervisor Wohlen, Assistant Supervisor L. F. Jefferson, and Pilots Bob Johnson and Bennett.

Overhead personnel was needed for a fire burning on the east side of the Clearwater Forest. Ground travel from the supervisor's headquarters to the fire would require days. Travel time could be cut in half by ferrying the men by airplane. Such use was new in those days.

Supervisor Paul Wohlen, Assistant Supervisor Jefferson, and three others boarded the plane in a hay meadow at Weippe, Idaho. Their route lay across the undeveloped, roadless wilderness country comprising the north fork of the Clearwater River drainage. It was a route new to the pilots so they flew high, 8,000 or 9,000 feet.

Upon leaving the high divide the ship came out over the Clark Fork River. Jefferson, being acquainted with that area signalled to the pilot that they were over the small village of Superior, the point at which they were to land. The pilot reduced the spark and throttle preparatory to maneuvering for a loss of elevation. Instantly the motor backfired and apparently a quantity of unburned fuel spread over the fuselage. It burst into flames. The fire spread quickly back over the ship, burning through and into the cabin. Johnson signalled to Bennett who put the ship into a power dive. This maneuver was to confine the flames to the body of the plane and prevent them from spreading to the wings. The plan was to plunge the ship into the river which was directly below. However, when within 200 feet of the river, he sighted the nearby landing field, levelled off and instead of taking the river, he set the plane on the small field, at something like 200 miles per hour, safely!

Throughout the downward trip the passengers were busy trying to keep the fire out of the cabin, fighting the fire with hands and feet.

1937. Observer Bill Farris, and Pilot Penn Stohr.

The Toboggan fire on the Clearwater Forest had been scouted and the boys were returning to Missoula in a six-passenger Travelair. The return trip required a climb of about 6,000 feet to clear the rugged Bitterroot Range. The country was rough, burned-over land, cut up by sharp ridges and crooked, narrow canyons.

They had traveled some 14 miles from the partially completed Forest Service landing strip at Cayuse Creek and had about 4,000 feet yet to climb to clear the divide when the motor threw a connecting rod and piston. The motor went dead.

Between them and the field were 14 miles of snags and cliffs. Swinging the ship around they began a glide in the direction of the field, searching for a brush patch or thicket of green trees in which to pile the ship. None came to view and each second reduced the distance between the ship and the treetops. Even facing into the wind, the ship lost elevation faster than the creek over which they flew. The canyon walls rose high on either side and still there were no brush patches—just spike-like snags. Each turn and twist of the canyon was the same, another expanse of cliffs and snags ahead. The ship would settle almost to the spikes, then a friendly up-draft would give a margin for one more bend. Any slight down-draft meant disaster.

After what must have seemed a lifetime, the ship caught a strong head wind, held elevation, and coasted to the Cayuse field, landing cross wind on the end of the clearing. It was ground looped to avoid stumps.

That this was a close shave is indicated by a note attached to the instrument panel when the ship landed. "To finder: Crash was no fault of pilot. Number 7 cylinder shot over Black Hawk Lookout." Signed Farris and Stohr.

The boys hadn't expected to reach the field. Fate again, somehow permitted the seemingly impossible escape of our forest flyers.

1938. Dick Johnson, contract pilot.

With a load of iron water pipe, aggregating some 4,000 pounds, in a Ford Trimotor, Dick Johnson, star mountain pilot, dropped between

the peaks of the Flathead Range into the canyon-bottom field at Big Prairie Ranger Station.

It was evening, following a hot, sultry day; the air was bad and Dick realized he must use every foot of the short runway. He dropped low over the stumps as he approached. When some 20 feet from the ground a down-draft struck the ship, smashing it to the ground. So quick was the drop that the shock cracked the pilot's chin on the control wheel. At that moment he had been in the act of reducing throttle and his hand rested upon the three ivory knobs. The blow on the chin rendered him unconscious. As he slumped down his hand somehow shut off two throttles; the third was left wide open.

The big ship hit, bounced, raced down the timber-bordered field, careened crazily into a wide circle, pulled by the one roaring wing motor; one man, unconscious in the pilot's seat, big trees ahead, two tons of iron pipe behind him, and traveling somewhere between 50 and 100 miles per hour. Straight for the ranger's office-cabin it bounded. Then one wing caught a tree trunk, its course was deflected, and it crashed into a clump of large trees between the office and barn.

Men in the station hearing the thunderous crash, rushed out to see a great mass of twisted aluminum, machinery and pipe, strewn over the entire grounds. The mass was dripping gasoline; big pools of it were forming in low spots on the ground.

From somewhere in this conglomeration of wreckage came Dick Johnson, crawling, staggering, bleeding, mumbling almost incoherently, "Don't any—light a match, she'll blow up!"

They sent another plane and stretcher for Dick. Three weeks later he finished the hauling job to Big Prairie.

1939. Clarence Sutliff—Dick Johnson.

Several trips had been made, dropping supplies to crews on the Roaring Lion fire. It was in an extremely narrow canyon formed by sheer rock walls extending thousands of feet into the air on either side. It was typical mountain-goat country, *where not too rough.*

On this last trip the boys found that the crowning fire had run down canyon, destroying the site which had been selected for their camp. To find a new one meant getting close to the canyon bottom. This they did, close to the edge of the running fire. Some 500 feet above the creek bottom and probably that close to the heavy smoke column, they banked for a turn which at best would be tight.

Just as they completed the turn the ship plowed into a waterfall of air; a down-draft caused by displacement of atmosphere heated by the fire. With motor wide open the ship fell lower and lower. To avoid the rock cliffs it was banked and more elevation was lost. Still the rush of air poured down on the plane. The trees and rocks jumped closer, and the top of an alpine fir was clipped by a wing. Dick shouted to Clarence who was in the rear of the cabin, "We're going down!" Then a big Douglas fir tree loomed directly in front.

Clarence felt sleepy when he awoke, rubbed his eyes, shook his head, and wondered what the sizzling noise was. Then he became conscious of a red glow—fire—the ship was on fire, wrecked. Or was the crown fire over them? Frantically he ripped at the walls that pinned him in. Through a hole half large enough, he somehow got out. The ship, or rather, the tangled mass of wreckage was not on fire. The noise was oil dripping on hot parts of the motor and the

crackling and roar of the approaching forest fire. The wreckage was on a steep boulder slide; some parts of the ship hung from nearby trees.

Clarence found Dick, head down, smashed among the twisted cowling and controls. He was streaming blood, unconscious or dead—examination proved his heart still beat.

With rocks, clubs, fingers, and shoes, Clarence beat away the tough steel enmeshing the pilot. Dragging him out, he attempted to bandage the exposed wounds to stop bleeding. Then he tried to set up a radio which had been brought for the new camp. It failed, and knowing that the fire was getting closer each second, he dragged, rolled, and carried Dick down the boulder slide to the creek. Here he could drag him no farther, so selecting a moist spot, most free from inflammable fuel, he left Dick and started for help. It was then dark so he blazed a trail through the jungle of brush and timber with a jack knife. Clarence was bleeding badly and each slash at a brush with the knife, also painted a red splash which could be followed days later.

To make the story short, Clarence found help and sent men to get Dick. A shift of wind direction held the fire away from the crippled pilot.

A few days in the hospital, a couple of weeks' rest, and these fellows were again in the air, fighting fire with airplane service.

1940. Del Clabaugh and Pilot Maricich.

The deluge of lightning fires in July 1940 had caused placement of 8,000 fire fighters in the forests. All reserves of ground transportation were working double shift, but still there were crews that could not be supplied by such means in the remote, inaccessible back country.

Regular forest contract pilots were flying every daylight hour. Reserve ships were available, but experienced mountain pilots were not to be found in the northwest.

A crew, struggling with a nasty fire in the Alp-like Bitterroots was known to be without food. They had no communication. Lookouts reported evidence of a nip-and-tuck battle, which would be lost unless supplies were delivered immediately.

A good, mountain-tested ship, (a six-passenger Travelair) was loaded. Bob Maricich, a skilled transport pilot but possessed of little mountain experience, was employed to take the load. Del Clabaugh, also a pilot, was to serve as cargo dropper.

Without event, the boys crossed the badly-wrinkled topography of the Montana-Idaho Divide and dropped down among the sharp ridges to search out the spot on which their load was to be dropped.

In this area, the ground surface is a jumble of white rock cliffs, slides, alpine timber, and spike-like crags. The creeks run white, foaming down courses which are continuous cataracts. In such a canyon, well toward the upper end, the pilot spotted what he thought to be a white "X," the target. Unfamiliar with the treachery of mountain air, he slid down to within a few hundred feet of the creek bottom. Then traveling upstream, he approached the spot, dropping a load with a cargo chute. Immediately he gunned the motor to climb out for another swing over the spot. At that point, the ship was well down between the canyon walls, facing up the steep grade of the creek bottom. A sharp bank was necessary and was attempted. The 330

horses in the Wright whirlwind responded to a full throttle and the turn was one-half completed when the force of a terrific down-draft caught the heavily loaded ship. The space for maneuvering was too small.

Lookout Harry Neilson, from his station on Cub Point, had watched the plane as it bobbed in and out of view among the ridge tops. He saw the cargo chute, a white dot, as it slipped into the canyon bottom. He heard the motor humming as the last turn carried the ship out of his view. He heard a crash or explosion; then from the canyon came a puff of dust or steam. The hum of the motor was heard no more.

Upon reaching the wreck, Neilson found Bob Maricich crushed and dead. Clabaugh was badly injured, but alive. The ship rested, a jumble of wreckage on the edge of a small, rock-bound pond among the trees. Another plane soon arrived overhead. First, a cargo chute bearing medical supplies and blankets, then a larger chute opened and a smokejumper trained in first-aid, landed close to the scene of the accident.

Clabaugh fully recovered. Bob Maricich's is the first grave in this region for which forest flying is responsible.

Pioneer Pilots

The Forest Service and Fire Control, in particular, owe a great debt to those individuals who, with an almost uncanny ability to master the uncertainties of machines and elements, have made forest flying a successful venture.

Many of these fellows have come to their untimely, final landings, not among rivers and forests, but in places where the most modern of safety facilities were available. Some who have felt their motors die in the center of a horizon of peaks, have met violent death in centers of civilization.

Lieutenant Priestly, who pioneered region 1 detection scouting in one of those DeHaviland death traps, crashed out while doing stunts at an air circus, in a "Jenny" at Spokane. The controls of the ship froze.

Lieutenant Bigelow, who landed a dead motor and took off again from the side of Mt. Baldy, met death in a crash while piloting an airplane at Pasco.

Jack Rose, veteran air patrolman and scout, who went down and walked out of a St. Joe jungle, died in a fall down a stairway of a building in Amsterdam, Holland.

Nick Mamer, pilot-idol of the northwest, who perhaps more than any other flier encouraged and promoted forest flying in the 20's, was killed while piloting an airliner near Bozeman. The tail assembly of the big ship dropped off in mid-air, at 250 miles per hour. Nick lacked only a few feet of making a safe landing in a small clearing.

Howard Flint, regional fire chief, and perhaps the best known of this region's foresters, was without doubt the real pioneer in Forest Service aerial work. Howard, a pilot himself, was for many years in direct charge of all airplane activities in the region. He acted as observer during the 20's when all sorts of "crates" were in use. He dropped the first supplies ever delivered to fire crews. He scouted

the forest fires to be mapped by air. He sought out most of the landing field chances in the region and planned their development. He initiated aerial photography as a mapping device and flew hundreds of hours on such work. He died as a result of pneumonia, contracted while making a raft trip down the Salmon River, "The River of No Return."

Conclusion

While this chapter has dealt with the disasters of forest flying, it is not written to frighten or intimidate those who must participate in such activity. Its purpose is to emphasize the fact that despite the good record, we have many times escaped by narrow margins. If there is a law of averages, applicable to accident frequency, the odds must be mounting against our good luck. Utmost care and foresight must be used in planning and conducting forest flying, else our record may be blemished.

As a needed precaution, the Forest Service should be permitted such authority as necessary to employ and retain year after year, the services of skilled, trained pilots, experienced in this particular type of flying. Authority for hiring ships and equipment designed especially for mountain flying is also necessary to safety.

Continuing, renewable, or long-term contracts would permit obtaining such facilities. At present, under legal restrictions which require solicitation of competitive bids each year for airplane service, there is no assurance that our lives will be entrusted to the most capable mountain pilots.

And one final word to dispatchers and fire bosses: Don't ask the flying boys to do the impossible or the obviously dangerous thing. Before putting them in a tough canyon on a hot afternoon, make sure you can't delay until the cooler evening air makes it more likely that they will return.

Closure of National Forests for National Defense.—As a measure of national defense it may be necessary to close certain areas (such as those surrounding power plants, etc.) of national forests to unrestricted entrance and travel. On January 22, 1941, modification of Regulation T–9 of the U. S. Department of Agriculture signed by Paul H. Appleby as Acting Secretary of Agriculture became effective. The following section was added:

"(k) The unauthorized going or being upon any area which, in the public interest, has been closed by the regional forester as a means of preventing the malicious destruction of, or injury to, property or works located thereon, or adjacent thereto, regardless of the ownership of the property or works. The boundaries of each area shall be defined by the regional forester, and, insofar as practicable, indicated by posting notices along such boundaries and on roads and trails leading into the area."

RAILROAD FIRES—A CHALLENGE

A. H. Abbott

Forest Supervisor, Cabinet National Forest

Fires started on railroad rights-of-way by locomotives, hot boxes, and so forth have been a cause of major concern to the fire-protection agencies involved and to the railroad companies who pay the cost of suppression and damage. There are few places where the problem is as great as on the Cabinet National Forest. The unusual situation found on the Cabinet is discussed in the following article, and light is shed on some of the problems of equipment and organization and the need for further effort. As these serious situations are sometimes coupled with a low reservoir of available manpower in the Forest Service and local communities because of emergencies elsewhere, the best in equipment, hazard reduction, and cooperative suppression plans is essential.

When the St. Regis ranger district was transferred from the Lolo to the Cabinet National Forest in January 1931, a large part of the region 1 railroad right-of-way fire hazard was concentrated on one forest. Since then, the Cabinet has consistently had more railroad fires than all the other forests in region 1.

The Northern Pacific Railroad runs through a canyon on this forest—an area of high temperatures, low humidities, erratic and gusty winds, and fast spread fuels. A study of the reportable fires occurring on and adjacent to the Cabinet for the 9-year period 1931–39 showed that 237, 25.1 percent of the total, were "extreme spread" and that of these "extreme spread" fires 168 or 70.9 percent were started by the engines operated by this railroad. Incidentally the average time on all "extreme spread" fires was 38 minutes from origin to arrival of the first man, average size when reached 3.4 acres, average spread per minute 0.09 acres. These averages cover only reportable fires. In addition, there is through the fire season the ever-present menace of nonreportable railroad fires, of which there were 405 in 1931, most of which are potential reportable fires.

Considering the acreage involved on the Northern Pacific right-of-way as against the rest of the acreage protected by the Cabinet Forest organization, and based on the number of fires which occurred, nonreportable and reportable, 1931–35, the chance for a fire on the right-of-way was 1,255 to 1 for the balance protected. Considering man-caused fires only, the chance was 2,290 to 1.

The Northern Pacific Railway Co., under the agreement of September 1921, furnishes fully equipped speeder patrolmen as called for by the forest supervisor. In 1940 nine such patrolmen were employed. Section crews, track and signal maintenance men, and other railroad men who travel by speeders are fully instructed about what to do in case of fire. Nonreportable fires are generally controlled by these men, but we never know when any fire will be more than they can handle and will require Forest Service action, or as usually happens, when a faulty ash pan, spark arrester, or a hot box will set a string of fires which the local patrolman cannot possibly control alone.

About 1929 the Northern Pacific started using lignite coal, mined

at Coalstrip at a cost of about 75 cents per ton on the cars, thus cutting fuel costs a very considerable amount. However, the coal throws a tremendous volume of sparks. Cyclone spark arresters were installed. When these spark arresters work properly, there are practically no sparks from the smoke stacks. Improper installation, friction wear by the ashes, etc., not infrequently occur, with resulting right-of-way fires. Moreover, spark arresters alone do not solve the problem, for about half the fires are set by sparks from defective ash pans. One engine set 29 fires in 40 minutes on the St. Regis ranger district in August 1940, during a dry lightning storm, while the district ranger was on fire-suppression work in the Yellowstone National Park. Other equipment failures are usually negligible, although one train with a hot box made 175 sets (reported as one fire) in less than an hour.

Each year crews employed by the railroad burn a large amount of inflammable material along the right-of-way. Cheatgrass (*bromus tectorum*) is the worst fuel. Burning this is a headache. Frequently cheatgrass will not burn at 9 a. m.; by 10 a. m. it will burn safely; by 1 p. m. it is explosive, and gusty winds make burning absolutely unsafe. It is usually inflammable from a week to a month earlier than other grasses. The uneven ripening, because of topographical and moisture conditions, further complicates the burning problem. Either burning must be deferred until all of the cheatgrass is ripe, and chances taken on fires starting in the patches of early ripened grass, or the ripe grass must be burned and chances taken on that which is not ripe enough to burn at the time.

Following the work done on the Shasta National Forest in California, the Northern Pacific Railway Co. expects to try out soil sterilization by use of arsenic trioxide on sample strips on each railroad division. If this proves feasible, permanent firebreaks should be made, which should be far better than the present plowed breaks. Such breaks can be made where topography and rock content make plowing impractical.

Burning rights-of-way, building firebreaks, quicker detection, and faster control are all desirable, but they do not solve the problem. The problem is to keep the sparks from leaving the engine, and that is primarily the responsibility of the railroad. Although their costs have been reduced, there is no good reason for letting up on the real prevention problem. It is not to be expected that the Forest Service organization will always be on hand to fight the railroad fires. We have repeatedly had every available man on fires. And sooner or later, when certain condition exist, i. e., a class 5 to 7 fire danger, large going fires, or a dry lightning storm, a fire-setting engine will go through and we will not have the manpower available to meet the situation. Such a condition existed in 1931, when the Kildee Fire started. The fire jumped the Clark Fork of the Columbia half an hour after it started, although there were 14 men on the fire in the first 20 minutes.

Many of us remember the labor situation we had to contend with from 1915 to 1919. Apparently we will have much the same situation to meet in 1941. The Northern Pacific is not the only railroad that sets fires. Isn't it of prime importance from a Nation-wide preparedness viewpoint for the fire-setting railroads to put their equipment in safe condition and thus eliminate the probability of tying up needed men, food, tools, and equipment on preventable fires?

AN AID TO ALIDADE ORIENTATION

WENDELL MORAN

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In manning three new lookout points on the Bear Valley district of the Payette National Forest during the summer of 1940, it was found that guards or lookouts who had had previous instructions in alidade orientation could complete the necessary operations, with a check-up later by the ranger. The method employed was as follows:

The alidades were set up in their proper positions and adjusted for level. The men on the new points lighted their gasoline lanterns at 9 p. m. on a specified date, placing them over the center pin of the alidade for a period of 1 hour. Mirrors, such as all lookouts and guards have for their personal use, about 4 by 6 inches, or a round mirror of the same size and preferably of glass, make satisfactory reflecting mediums. The lookout stood directly behind the lighted lantern with the mirror's reflecting surface in a vertical position about 6 inches from the light. With the mirror in this position, he slowly walked around the alidade, keeping the mirror's reflecting surface behind the light. Walking around the alidade caused the light to flash in much the same manner as the revolving screen in a lighthouse. The resulting flash was penetrating and could be seen satisfactorily for 15 miles.

The other established lookouts took readings of the flashes at spaced intervals; that is, until they were sure it was a light and not a star. These readings were communicated to the respective new lookouts, and the alidades were adjusted by sighting the established points—using the reverse readings. The alidade map was adjusted to fit the readings obtained. Because of an error in map printing, a slight adjustment of the map was often necessary.

If the alidade is located on an exposed point, the lantern should have a mica or glass globe to prevent the wind from blowing out the flame. Also, without the use of the mirror it is hard to see the lighted lantern any distance and practically impossible to see it if the lookouts on the established points are looking toward a light sky background such as prevails in the summer evenings.

A RUST-PREVENTIVE TREATMENT FOR FIELD CACHE TOOLS

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Fire tools will not be rusty when they are needed if they are treated in certain ways. Some effective methods of treatment are rather expensive; other methods may lack effectiveness and have other disadvantages. The method described herein will appeal to district rangers or forest guards at isolated stations where both money and facilities may be scarce.

Tools stored in field caches are exposed to more or less dampness. Various treatments, using different kinds of oil and grease, have been tried to prevent such tools from rusting. Nearly all of them have had some objectional feature.

The need is for a rust preventive that is cheap, efficient, and easy to apply. Following is a summary of experience with ordinary commercial paraffin, such as is used for sealing jelly jars and which sells for 10 to 15 cents per pound:

Two new double-bit axes were thoroughly cleaned of all foreign matter by several washings in clean gasoline. They were then wiped dry with a clean rag. We next made a solution of brine, consisting of 1 part common table salt to 5 parts of water. Ax No. 1 was covered with a heavy coat of oil and ax No. 2 was given a coat of paraffin which had been heated until it liquefied. Both axes were placed in the brine solution for a period of 24 hours.

After removing the axes from the brine solution and cleaning off the oil and paraffin, it became evident that the paraffin was the better of the two rust preventives. Ax No. 1, which had been treated with oil, was badly discolored and spotted over its whole area, and after it had been out of the brine for ¾ to 1 hour it commenced to show evidence of rusting. Ax. No. 2, which had been coated with paraffin, showed no evidence of discoloration or stain except at two places where the paraffin coat had been scratched in handling. These two places had become slightly discolored, but the discoloration rubbed off easily with steel wool. Since it is very doubtful that any ax in a cache would ever be exposed to the treatment given these two axes, it does not seem that small cracks in the paraffin coat would ever allow enough moisture to penetrate to even discolor the metal as it did in this experiment.

The paraffin has the advantage over oil of coating the tool with a moisture-proof covering. It is much cheaper than oil, does not cake on the metal, and when the tool is placed in use does not need to be removed since it flakes off readily. Furthermore it is easily applied.

Oil has the disadvantages of being dirty to handle and of getting all over everything if not put on carefully. It takes time to apply oil, and if the tool is not coated all over, rust spots appear on the exposed parts. Oil is also more expensive than paraffin.

Several tests were made in coating tools in the field. The first was undertaken in February 1940. Melted paraffin was mixed with benzine in a ratio of 1 pound of paraffin to 1 gallon of benzine. The mixture was wiped on with a rag over 23 double-bit axes and 8 Pulaski tools. All parts were covered, as were the ends of the handles. The total amount of the mixture used for treating the tools was 1 pint. The use of a rag for wiping the mixture on the tools did not seem satisfactory because of the daubed appearance it gave, and the uneven coating of the tools. However, not one tool shows any evidence of rust at this time and not a single loose handle has been found among the lot.

A second test was undertaken on the tools in one of the field caches, the results of which are not yet known. Melted paraffin was mixed with white gasoline in a ratio of 1 pound of paraffin to 1 gallon of gasoline. Instead of applying the mixture to the tool with a rag, as was done in the first test, each tool was dipped in it. However, in treating a saw it was necessary to use a rag to apply the mixture.

In applying the paraffin mixtures it was found that the tool to be treated had to be warm to the touch. When cold tools were treated, the paraffin immediately congealed on contact with the metal and an unnecessarily heavy coating was deposited. It was found also that the mixture of paraffin and gasoline, which seemed to be the most desirable of the two mixtures used, would keep in liquid form for only a few days because the gasoline evaporated and the paraffin congealed. However, this might be avoided by placing the mixture in an air-tight container or by mixing it only as needed, which is even more desirable.

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